Household food-waste production and a proposal for its minimization in Mexico

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Abstract: One effort to encourage households to reduce their waste is based on educational programs. However the educational-program evaluation is nascent and there is a lack of and poor quality of proposals. This field study contributes to the filling of this literature gap. Forty-one volunteer families took part in a quasi-experimental study with two nonrandomized groups, using a pretest and posttest design. During a full year, wastes were weighed weekly (1,432 samples) and a workshop aimed at the minimizing of food-waste production behavior, home technology, and composting was offered. Significance differences (95%) were measured when a paired Student's *t*-test and a Chi square test were used. Four main conclusions were made. (1) The average production of food wastes in Mexico was similar to other developed countries, (2) the food-waste reduction and the workshop were not independent, (3) the workshop increased environmental awareness and capacity building, and (4) food-waste weighing was a feasible and robust tool to measure the impact of the workshop.
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1. Introduction

A current challenge is now understood to be one of fostering more environmentally friendly forms of consumption at the level of households and individuals (Evans 2011) to achieve sustainable development. Sustainable consumption implies environmental friendly goods and services and less consumption. The Organization for Economic Cooperation and Development (OECD) (2002) defines sustainable consumption as "the consumption of goods and services that meet basic needs and quality of life without jeopardizing the needs of future generations". Lorek & Fuchs (2011) call it de-growth, Evans (2011a) as frugality, and Cooper (2005) as a slow consumption implying the purchase of goods that will not frequently be thrown away.

Mobility, food, and housing are key units of the analysis for consumption policies everywhere in the world (Spaargaren 2011). The household sustainable consumption has been approached by using several tools and it has been especially focused within the study of the domain waste or energy (OECD 2002, Caeiro et al. 2012). In this case, our interest is to focus on waste as a direct, visible, and measurable expression of household consumption and because reducing food waste is an important and underemphasized strategy to confront the challenge of feeding a growing world population without increasing the environmental burden of production (UNEP 2011). According to Pascoe & Vivero of the FAO, nearly 40,000 persons could be nourished daily if food waste were avoided.

The food waste is important as a proxy of household consumption, but also such kind of waste is important because of problems generated for their proper management and final disposal, especially in Mexico City where the main landfill "Bordo Poniente" was closed in December 2011. Currently, wastes are taken to different private and expensive landfills located in the State of Mexico. Most of waste is used for landfill because Mexico has the least coverage of recycling services (OECD 2011) so that waste production and disposal are great problems.

For global food waste, the majority (60%) of more than 10,000 tons of food waste is generated annually by consumers (Griffin et al. 2009). The majority of urban solid waste is produced by households; about 80% in developing countries (Troschinetz & Mihelcic 2009), 77% in Mexico (OECD 2006-08), and < 40% in developed countries such as Finland (OECD 2004) This is definitively related to household size and the number of households (larger and more in developing countries). According to the OECD (2011), municipal waste will increase by 38% from 2005 to 2030, with waste generation the main environmental impact from household consumption.

Even though there is a growing concern about food waste (Gustavsson et al. 2011), there has been little research about several aspects (Langley et al. 2010). Calderón et al. (2010) noted that household

food waste is difficult to determine and there are some obstacles present. Rudd & Johnson (2008) mentioned sociopolitical obstacles when entering a home to weigh food waste, and Geyer-Allély & Zacarias Farah (2003) stressed that the use of direct regulation on households is relatively rare because it is difficult to implement and it is intrusive.

Gustavsson et al. (2011) report amounts to about 1.3 billion Mg per year of food waste (~350,000 kg/day), depending on the kind of economy. Same authors report that in Europe and North America the waste is 95-115 kg/capita/year (0.26 - 0.32 kg/capita/day), in Taiwan it is 0.26 kg/capita/day (Kuo & Lai 2010), whereas in Africa it is only 6-11 kg/capita/year (0.02 - 0.03 kg/capita/day). Kitchen waste typically is 17% -22% of total home waste.

According to the OECD (2004), in the European Union, food and gardening waste represent 23% (Austria) to 49% (Spain) of total municipal waste. In Mexico City, data produced by the Japanese International Cooperation Agency (JICA 1999) indicated 38% of food waste is in the composition of home waste. Combining the data from JICA (SMA, Distrito Federal) and the 2010 population census (INEGI (b)), in Mexico City, the household food-waste production has been similar over the last decade, 0.24 kg/capita/day in 2000, in 2005, and in 2010, with a value > 0.15 kg/person/day being calculated for the country as a whole based on a percentage proposed by the JICA.

For previous waste studies and waste education, a large number of studies have discussed the management of solid wastes only from their collection to their final disposal (Ojeda-Benitez et al. 2008). No generation was considered. Most studies are focused on the use of organic wastes (food, gardening) for anaerobic digestion, incineration, composting, animal feeding, and the production of biofuels (cf. Subosa 1992; Nguyen 1997; Chakrabarti 1998; Ojeda Benitez, Armijo de Vega & Ramírez Barreto 2003; Lundie & Peters 2005; Chanakya et al. 2007; Brandé, Vikman & Brattebo 2008; Chakarabarti Majumder & Chakrabarti 2009; Ruggieri et al. 2009; Pourbafrani et al. 2010; Lohrasbi et al. 2010; Hermann et al. 2011; M-H Kim 2011). The home composting process is the most popular recommendation but it has many contradictory results as stressed by Colon et al. (2010). Despite such contradictions, some authors consider it as one of the most environmentally beneficial activities (Loundie & Peters 2005; Chanakya et al. 2007; Karnchanawong & Suriyanon 2011).

Others point out the environmental disadvantages of home composting (Loundie & Peters 2005; Amlinger, Peyr & Cuhls 2008; Andersen et al. 2010; Williams & Wilström 2011; Hermann et al. 2011; M-H Kim 2011). Certainly the composting of food waste can have a major influence on waste minimization, as mentioned by Eriksson et al. (2005), but it is difficult to store food wastes (Geng, Tsuyoshi & Chen 2010) especially in urban apartments. It depends on the quality of feedstuffs (Refsgaard & Magnussen 2009) and it is an “end of the pipeline solution”. Therefore, waste prevention instead of waste control must be emphasized.

Efforts to encourage households to introduce changes in waste generation behavior have been usually focused on the final disposal but not in reduction. Examples are that made in some countries like United States and based on volume fees, recycling infrastructures, yard-waste collection, and educational programs (Geyer-Allély & Zacarias Farah 2003; Geng, Tsuyoshi & Chen 2010). Waste fees certainly could impact behavior, but as the OECD (2011) pointed out, waste fees as a strategy for waste prevention could be effective, but as a punitive action it is not a long-term strategy. Smith et al. (2012) stress that taxes and fines may lead people to reason that they can continue to engage negative behavior as long as they have the ability to pay. It is not clear whether incentives can sustain long-term lifestyle changes if they are later removed.

Other initiatives to introduce changes in waste-generation behavior, such as those of social marketing, can involve demarketing of littering or the promotion of recycling. However the majority of such campaigns relate to personal health (Peattie & Peattie 2009). Other studies focused on recycling (Prestin & Pearce 2010) underline that campaign planners might consider improving the users’ knowledge of what is recyclable rather than bolster recycling, by using educational strategies for sustainable development. Even education fails sometimes, though it is effective in fostering compliance of social norms (López-Pérez 2009). Previous studies had shown households that receive environmental education, i.e. against wood heating, decreased environmental impact (smoke emissions) more than those not receiving it (Hine et al. 2011). So it is clear, education supports initiatives related to sustainable consumption and it is a long-term strategy (Geyer-Allély &. Zacarias-Farah 2003), as mentioned also by Lilja (2009).

Learning by experience and action competences is seen as being central concepts for improving environmental education for sustainable development (EESD) (Ellis & Weekes 2008). The EESD related to food has been focused on practical cookery demonstrations using local produce (Chikami & Sobue 2008), a quality focus, but quantity is not considered. The EESD means, among other meanings, moderation in consumption and material efficiency skills, especially within the home as the dominant site

of practice in which a sustainable lifestyle has been promoted (Barr, Gilg & Shaw 2001). Based on this, the EESD and its assessment must be focused on these two concepts, moderation and efficiency, that is frugality (Evans 2011a). Yet educational assessment is a nascent and a problematic field (Stake 2009) and there is a lack of and a poor quality of proposals (Fleming & Easton 2010; Crohn & Birnbaum 2010).

The evidence of environmental learning must be more than the declarations or pure answers of standardized tests; they should be concerned with environmental benefits. The studies made, such as mentioned by Bench et al. (2005), noted measures on waste reduction are based on the perception of the respondents; the study made by the WHO showed almost 60% of residents indicated a reduction of 25% –50% of biowaste. The aim of educational interventions is to get people to internalize positive personal and collective attitudes and behavior (Chifunyse et al. 2002). Dominant research traditions in education (see Bailly 2008; Nagao 2003 cited by Hashimoto, Pillay & Hudson, 2010) are interested in Capacity-Building so evaluation must be focused on the success of any characteristic of this kind of educational outcome. In one sense, quasi-experimental and experimental techniques are tools for educational evaluation, however because of the challenges educational evaluators face when implementing them (Rudd & Johnson 2008), few experiences related to these techniques are documented. Capacity Building (CB) is a broad concept and a variety of characteristics are used to define it such as abilities (to decide, to behave), knowledge, technical expertise, skills, tools (in many topics), leadership, procedural capacities, motivational capacities, economic capacities (Fleming & Easton 2010, Simmons et al. 2011, Kuhlicke et al. 2011). In this paper CB is understood as developing of abilities to behave, the presence of knowledge, skills, and tools.

For the method of food-waste-reduction measurement, the literature cites written and video diaries and questionnaires (WRAP 2009a; WRAP 2009b; Reid, Hunter & Sutton 2011, Roberts 2011) in monitoring environmental behavior. Even though they are useful to record behavior, one key disadvantage of dairies is that they are a self-reporting element, so it depends fully on the subject and it is clearly a subjective method.

There is a large amount of literature about questionnaire use. They are also self-reporting and usually used pre- and post-intervention (Barberger Gateau et al. 2006; Refsgaard & Magnussen 2009); Wai-Tong et al. 2006; Li-Min, Chi_Chun & Chung-Hey 2009; Alvarez Suarez & Vega Marcote 2010 as leading references). When focused on behavior, evaluation is often right after the intervention, with most having assessed the short-term effects (Reid, Hunter & Sutton 2011), but it is well-known that over time behavior fades away (Birkeland Murphy-Graham & Weiss 2005), For this reason, authors (Stes et al. 2010) have underlined the necessity of developing evaluation methods other than self-assessments, because questionnaires have limitations.

In light of all these scenarios, studies have called for the examination of the longer-term effects of the intervention (Abrahamse et al. 2005, Stes et al. 2010, Fleming & Easton 2010) advocating the development of techniques that create 'self-sustaining change' beyond the period of the intervention.

Our main purpose of this study was to propose an innovative and objective way to assess the middle-term effects of educational intervention as an implication of subject learning in the frame of a learner-centered viewpoint. Our second aim was to measure household food waste as a proxy of consumption. Two research questions were posed; does education on food technology, composting, and socio-environmental problems such as undernourishment, poverty, food production, and the environmental impact influence food-waste reduction?, and is food waste weighing a feasible environmental educational assessment? We have assumed that the household food-waste reduction is a feasible measure of the impact of an educational intervention and the household food-waste reduction and the workshop are not independent.

2. Material and Methods

This study was made in Mexico City. The first contact was made at the Catholic Church. A brief questionnaire was developed, just asking the potential attendants their contact information and potential acceptance to participate in this study. We explained that acceptance involved giving facilities for weekly weighing of waste at home and the attendance at the workshops. Those who accepted were interviewed pre-workshop about the actual destination of unconsumed foods, and general questions about the environmental impact of food production and improving the environment from the home.

It was a quasi-experimental study with two nonrandomized study groups, using a pre- and posttest design. Forty-one volunteer families took part in this project. The inclusion criterion was living in either of the two neighborhoods of the Catholic Church. All participants were informed about the aim of study "calculate food waste generation during the year". When the workshop was ready for implementation, the families were provided information about its contents.

Families who attended the workshop were assigned to the experimental group (8 families) and those who did not take the workshop were assigned to

the control group (33 families). Socioeconomic data were collected for the studied population to assure that sampling was homogeneous. The content of the workshop addressed two main aims, which involved raising awareness of the impacts of food consumption on 1) health and 2) the environment, and a secondary aim to develop skills and technical expertise. The didactic basis was grounded on reflexivity (and oriented toward the consequences of food consumption, considering, as Shanahan et al. (2003) argued, that if the impact on the environment resulting from our food consumption is not directly visible, it is harder to change our dietary habits. Because the majority of people are consequentialists (Jin Li, 2008; Reid, Hunter & Sutton 2011; Johansson-Stenman, 2012, and many others), recognizing the consequences of one's actions may result in behavioral change.

The 32 hour workshop was offered in 6 sessions which met weekly. The activities developed and information presented were linked to the subjects' circumstances to encourage reflection. No ideal behavior is promoted, but instead one's accessible actions are. For the first aim, the audience members calculated their body mass index (BMI) and filled out a 24-hour recall sheet. Subsequently, the nutritional value of the main foods they consumed was calculated. Participants were questioned about a healthy BMI and the possibilities of personal dietary changes. For the second aim, and to help participants move toward more responsible and environmental food consumption, examples of food, virtual water, CO_2 fingerprint, waste production, poverty, and hunger data were presented and discussed. The general framework of the practical content was addressed at making the most efficient use of available resources (food). We emphasized that efficient use is a key element of a sustainable waste-management system, as proposed by Seadon (2010).

For reducing avoidable food-waste production, the audience was taught home food technology (capacity building). Depending on their preferences, they prepared orange marmalade, tomato purée, fruit in syrup, or others. For the reuse of foods (avoidable food waste), the workshop instructors prepared dishes made from leftovers. For example, "meat burgers" made from lentil soup paste or "tamales" made from soaked and ground corn tortillas. To stimulate rapport with the workshop participants, a conversation was started and information about local food production and the importance for the environment of reducing and reusing food and recycling foodstuffs was provided (capacity building). At the end of the session, the ingredients of the meals tasted were revealed and the recipes were given to the audience.

Each attendant provided reflections about the workshop and expressed a number of personal and household commitments. For recycling, the audience was taught to make compost from inedible food (unavoidable food waste) (capacity building). Table 1 and Table 2 show topics and learning activities involved in the workshop.

Quantitative and qualitative educational evaluation was used in the study. The indicator, organic waste/capita/day, was developed. The middle-term evaluation proposed is focused on effects it produces not immediately but over time (middle-term) so the organic waste was calculated for a complete year through weekly calculations. Households turned in a day's waste to collectors. A total of 1432 samples were obtained. Waste was taken to our Research Center for weighing The weight calculations were always done on the same day by the same visitor and on the same scale. None of the participants were known by their weekly waste weight. The average weighing data was shown in workshop sessions comparing it with that of several cities and countries. For each family who attended the workshop, the data on the pre- and post-workshop waste-production average were analyzed by a paired Student's *t*-test using the Statistical Package for the Social Sciences (SPSS 17, SPSS INC). Only data from families who attended every portion of the workshop was used. The food-waste production of families who attended the workshop and those who did not attend were analyzed by a Chi square test using the same statistical software.

3. Results

Housewives were subjects that volunteered to attend the workshops related to food technology, food environmental impact, and other topics. Was it caused by their role or their environmental behavior? A possible explanation is that women are currently the ones in charge of deciding what meals to prepare, making home purchases, and the role they play in food habits within the family. This role has been confirmed by several studies (Wachs 2008; Bellesa, Forste & Hass 2005; Sakisaka et al. 2006; Ruel et al. 1999; Vereecken, & Maes 2010). For the environmental behavior of men and women, there are contradictory research findings. Some surveys indicate gender plays only a minor role in recycling behavior (Saphores, Ogunseitan & Shafiro 2012; Azjen 1985 cited by Wang et al. 2011), whereas others note that women are more likely than men to have a green behavior (purchasing) (Cullen & Stembridge 2011). Littering is more common among males (Al Khatib et al. 2009). Gender is important and that may entail needs of environmental sustainability (O'Shaughnessy & Krogman 2011).

Food-waste weighing was the method for measuring food-waste production, a learning assessment, and monitoring consumption behavioral change. Conversely to the use of questionnaires, food-waste weighing was demonstrated to be a realistic, quantitative, and direct method for the monitoring of changes in environmental behavior.

The families who attended the workshop showed reduced food waste when compared with themselves (pre- and postworkshop) (Table 3). A Chi square 2 x 2 test made using attending families who significantly reduced food waste (FAr), attending families who do not significantly reduce food waste (FAnr), nonattending families who reduced food waste (FNAr), and nonattending families who do not reduce food waste (FNanr).The Chi square was 12.4; P = 95%. The independence of workshop attendance and reduced food waste was rejected. The workshop significantly influenced food waste reduction. The technical contents and effective links during the workshop must be taken into account to explain the differences found. The effect of possible temporal-behavior change caused by weekly waste measurement does not have an effect on waste reduction compared to the effect of the workshop.

The reasons to change behavior were deduced from the answers to the questionnaire, pre- and post-workshop. The question asked what do you do with the foods that you prepared during the week and did not consume? Before the workshop, they reported they gave them to their pets, gave them away, or threw them away. After the intervention, the answers were “freeze them and consume them later”, “throw them on their plants” or gave them to pets”, “use to produce compost, “cooking only what is necessary”, and “preparing them in another way to be consumed as we were trained”. After the workshop, subjects enhanced their skills for their waste production.

Another question asked was do you believe that food production affects the environment? Before the workshop, most of the attendees did not recognize environmental effects caused by food production, but after the workshop the majority was able to identify examples of this effect. When householders were asked to mention three examples of this effect, before the workshop only two persons mentioned effects and gave examples such as gastrointestinal diseases or waste production. After the workshop, the examples mentioned were “high water consumption in food production”, “littering with food packages wastes”,” smog”, and “litter when waste is not separated”. The workshop allowed attendees to increase their awareness on environmental impacts.

Another question asked was from your own household, could you help to improve the environment? Before the workshop, all of them answered yes and in the following question they mentioned these examples “not to consume in street stalls”, “to give them environmental education”, “to communicate with the neighbors”, “separating waste”, “not to throw it in the street”, and “gathering my garbage”. After the workshop, the examples were more diverse. Some persons repeated their point of view “to separate my garbage”, “to put garbage in its place”, “to take care of the trees”, and “to sweep the street” and added “to make extensive the invitation to relatives and friends for its development”, “to take care of the water”, “to compost organic waste”, “to preserve seasonal fruits”, ”to recycle paper”, “not to buy disposable goods or to use them several times”, “trying to use only what is necessary”, and “not contaminating with garbage”.

Food waste weighing was a realistic and field-evaluation tool of educational intervention success. For waste production, the average was 0.32 kg/capita/day. The average amount found and that developed countries such Europeans and United States of America (0.32 kg/capita/day) is similar (data from Gustavsson et al. 2011), whereas the national average reported by JICA (0.15 kg/capita/day) is lower than our results, as was the average reported for Mexico City in previous studies (0.23 kg/capita/day based on JICA-INEGI data, 2010). If the behavior of the people studied changed temporarily because of the presence of our research personnel, then the average amount of food waste is underestimated because food-waste production in the studied neighborhoods is greater than 0.32 kg/capita/day.

For waste reduction, the maximum reduction of food waste recorded in our study after the intervention was 0.12 kg/capita/day. When the Student’s t-test comparison was made for the mean of all attending families, significant differences were found (t = 2.43, P = 0.045, 95% significance). Within the families participating in the workshop, the maximum reduction in waste production after the teaching intervention was 38%, whereas the minimum was 5%. The data are congruent with other studies. The WRAP (2010) showed about 42% of the food waste is avoidable and 5% is caused by the intervention. During the study, several families reported to visitors that they did not have food waste to dispose. Before the workshop, families did not have food waste to dispose on 1.3 days on average. After the workshop, the time was increased to 3.7 days.

Table 1. Food habits workshop. Topics

Topic	Component of Aphorism (practical activities)			Aim (raising awareness of reflection strategies)	
	Reduce	Reuse	Recycle	Health	Environment
Body mass index calculation				X	
24 h recall sheet filling out				X	
Nutritional value calculation				X	
Virtual water					X
Food miles-CO2 fingerprint					X
Waste product ion					X
Poverty and hungry				X	X
Food technologies	X				
Leftovers usage		X			
Composting			X		

Table 2. Workshop Program

Activities. Topic	Didactic strategies	Materials and timing
Session 1		
Knowing us	Introduce yourself	1h
Body mass index calculation	BMI table group discussion	Rule, scale, paper, pen, board, board pen, (2h)
How do I feel about my BMI?	Collective Reflections	2h
Session 2		
24-h recall sheet filling out	smart dish discussion	24 recall sheets, nutritional pyramid (3 h)
To eat or to nourish. That is the question	Nutritional value calculation from recall sheets (each attendant)	Mexican nutritional tables (3h)
Session 3		
Virtual water	data exposition, colloquial indicators calculation	Virtual water data of recall sheet most frecuent food (MFF) (3h)
CO2 food fingerprint	Where do I buy my foods?	Air pollution calculation (3h)
Session 4		
Waste production	How much waste do I produce?	Data from their own household (2h)
Poverty and hungry	Exposition	world statistics, ppt, map (2h)
Leftovers usage	dishes, discussion	dishes, recipes (1h)
Session 5		
Food conservation	Home food technology	Fruits, bottles, spoons, gloves (4h)
Leftovers usage	Dishes discussion	Dishes, recipes (1h)
Session 6		
Waste evaluation	Composting procedures	food waste (from previous lesson) box, plastic bag, soil) (3h)
Leftovers usage	Dishes, discussion	Dishes, recipes (1h)

Table 3 Paired Samples Student's *t*-test

	Paired differences					*t*	df	Sig (2tail)
	Mean	Std desv	Std error	95 confidence				
				Low	Upp			
Pre-Post	0.038	0.085	0.014	0.008	0.067	2.6	34	.014

4. Discussion

This study is focused on the premise of waste generation as a proxy for household sustainable consumption. The prevention of waste generates sustainability rather than waste control by using education as the vehicle for less consumption and reduction of food-waste production. In this study the potential obstacles for weighing food waste was

overcome because our first contact was made at the Church, by the diligence of the research personnel, and the face to face contact scheme. The success of face to face teaching strategy has been emphasized by several authors (Grodzi´nska-Jurczak et al. (2006); Reid, Hunter & Sutton 2011 among others). The facilities of the Catholic Church, in a country mainly Catholic, deserves consideration for future educational interventions.

The workshop was our selected strategy to cause the prevention of waste. Certainly, waste fees or fines can favor waste reduction but the effects of such punitive strategies on responsible consumption are less durable. The weighing of food waste as made in this study is a robust evaluation of middle-term effects on environmental-behavior change. The workshop was the teaching intervention but it is necessary to consider that interactions among teachers and learners influence learning (Hardré, Slater & Nanny 2010). Then interaction among the research personnel and participants could have promoted waste reduction. In one sense, weekly household visits were another kind of intervention and these produced some impact in the behavior of the families.

The household visitors cued people with environmental behavior and it affected proenvironmental self-perception and attitudes of the householders. Similar results were found by Cornelissen et al. (2008). A kind of personal relationship between the visitors and householders was built. Empathy and solidarity were interpersonal rewards as found (within environmental volunteering) by García Valiñas et al. (2012). Letting the food waste being weighed constituted an environment commitment itself and a reduced waste production was an expected outcome. Other studies, such as those made by Stes et al. (2010), concluded that "There is evidence that instructional development interventions that extend over time have more positive behavioral outcomes than one-time events". WRAP (2010) and Reid, Hunter & Sutton (2011) pointed out that household behavior changes when interventions occur. In our work, because the two study groups (attendants and non-attendants to the workshop) were visited weekly, the effect of weekly household visits was not significant compared with the effect of the workshops.

The workshop attendees had a certain degree of awareness about the environmental improvement. However, the increase of the diversity of answers offered after the workshop allows us to infer that their awareness was improved. The post-workshop weekly visits allowed us to confirm composting by some families.

Knowing which day the waste would be measured might help people change behavior temporarily. This kind of effect has been documented in other studies, which have shown deviations in self-reporting (Gil & Mora 2011) and food habits. Deeper studies are required to determine how environmentally significant the waste reduction is because of household visits and the interaction among the research personnel and householders, considering that positive moods increase the reliance on schemes and heuristics (Pretz, J. E., K. Sentman Totz, & S. Barry Kaufman (2010). For most learners a significant interaction is the learning precursor (Fullan & Stiegelbauer, 1997) or as proposed by Spaargaren (2011) that interaction as a sort of ritual and that "the more frequent, intense, and dense the enrollment of individuals in sustainability-related interaction rituals, the greater the chance that their commitments and levels of awareness will increase".

To improve results, additional strategies are also required, as has been shown by other studies. For example, Grafton et al. (2009) noted that "although social norms and general attitudes towards the environment do not appear to have a statistically significant effect on total household water consumption, in tandem with information-education campaigns about water saving behavior and the adoption of some water-saving devices, help to regulate residential water demand". Mora et al. (1981) found that home nutritional education moderately enhanced child nutritional status, but this alone did not improve physical growth.

In our study, it was not possible to determine if reduction was caused by an avoidable or unavoidable food waste. Some further studies are recommended. Because of the environmental and economic impact of food waste, even beyond such a low level (5%), it is an important reduction. This perception is similar to that which was suggested by Brandé et al. (2008), who considered waste reduction of 1% per year for 20 years as an acceptable target for waste minimization.

The workshop helped to improve environmental awareness and capacity building on waste separation, home food technology, and food-waste composting. Similar results were obtained by Papadopoulos et al. (2009) when working with a pilot implementation of the home composter and WRAP (2010) in door-to-door food-waste collection. Indirectly such practices also have a positive impact on consumption itself.

Because the level of environmental awareness and concern has an influence on consumption (Zacarias-Farah & Elaine Geyer-Allély, 2003) "waste generation decreases as the ranking of

environmental concerns increases" (OECD 2011). Household visitors cued people to environmental behavior and it affected the pro-environmental self-perception and attitudes of the householders. Similar results were found by Cornelissen et al. (2008) in environmental volunteering. A kind of personal relationship between research personnel and householders was built. Therefore, having food waste weighed constituted an environmental commitment itself and waste production reduction was then an expected outcome, as has been reported by García Valiñas et al. (2012). Empathy and solidarity were interpersonal rewards also found by those authors. In our study an effective link was established between the research personnel and the housewives.

The teaching interventions, such as a home education program that involves all family members, will improve these results as Ojeda-Benitez (2008) notes that "family exerts a profound and lasting influence on the perception and behavior of its members, both in the consumption and in waste generation and handling". Similar recommendations have been made for other topics, such as obesity prevention (Ramos de Marins et al. 2004).

Other efforts for waste prevention related to food are those related to better "easy actions" purchasing decision, as they are called by Evans (2011a), such as minimal packaging (bags, envelopes, boxes). Generalization of food packaging reduction as a strategy in waste minimization is questionable because of its role in food-loss prevention. Packaging is a strategy for food-waste minimization in a life-cycle perspective (Williams & Wilström 2011). The packaging prolongs the food life-cycle, so food by-products are a better strategy than packaging reduction.

This study contributed to filling the literature gap related to field studies on quantifying home food-waste production. It also documented one of the few experiences related to quasi-experimental designs in environmental education contexts. Specifically in our study, measures on waste reduction are not based on perceptions or oral information or self-reporting from respondents but in the weighing of the waste.

Among the studied population, the average production of food wastes was similar to that of developed countries. This waste generation data could be underestimated because although it was not a self-report, it is possible that housewives delivered a smaller amount to the visiting personnel than they really produced.

For purposes of testing the effectiveness of the workshop, the influence on the generation by the presence of visiting personnel does not matter, because both the families who attended and those who did not attend the workshop were affected by the visits. The workshop favored an effective link between housewives and instructors. This link could also influence a decrease in waste generation affecting the pro-environmental self-perception and food-waste reduction commitment of the householders.

The results helped us to assure that food-waste reduction and the workshop were not independent and food-waste weighing was a feasible and robust tool to measure the impact of the workshop. People who attended the workshop showed more food-waste reduction when compared with themselves (pre- and post-workshop) and with those families who did not attend the workshop.

The workshop increased sustainability awareness, specifically responsible consumption awareness, capacity building on waste separation, food home technology, and food-waste home composting From the pre- and post-workshop questionnaire used, the data shows that participants who attended the workshop significantly increased their information on the status of environmental impact and social problems related to food. They also developed more options to take advantage of food (food tech, re-prepare, composting)

Each success in waste reduction motivated them to even increase their commitment, which was reflected in even a higher decrease in food waste. Environmental awareness probably was not the only reason to promote behavioral change, but also social awareness concerning poverty and hunger.

Our results were pedagogically and environmentally significant. The training programs as documented in this paper would help to stimulate personal motives for food-waste prevention. Undoubtedly, involving all family members in educational interventions will improve these results. The challenge is to add efforts of the government, nongovernment organizations, mass media, and academia to achieve zero food waste in landfills.

This study demonstrates that the educational intervention (workshop) is a strategy for food waste prevention and probably preferable to waste fees, taxes, or fines. Three more issues are important. One, the household is an important but difficult institution to work with, but this study proves that working with households is possible despite the daily insecurity suffered by inhabitants in Mexico City. Forty-one families visited weekly for a whole year is proof of that. Second, in the study documented, housewives were the main attendees at the workshop, and some further studies are needed to arrive at consistent data about environmental gender differences. Third, probably the results obtained are also influenced by moral issues and values in the population studied.

People were contacted in the Catholic Church. Further studies would be needed to demonstrate the importance of religious values in pro-environmental behavior compared with nonreligious people.

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