Motivating Online Engagement and Debates on Energy Consumption

Lara S. G. Piccolo
Institute of Computing (IC) - UNICAMP
Knowledge Media Institute (KMi)
The Open University
piccolo@ic.unicamp.br

Harith Alani, Anna De Liddo
Knowledge Media Institute (KMi)
The Open University, United Kingdom
{h.alani, anna.deliddo}
@open.ac.uk

Cecilia Baranauskas
Institute of Computing (IC)
The State University of Campinas – UNICAMP, Brazil
cecilia@ic.unicamp.br

ABSTRACT

Several studies and official reports argue that changing people's behavior towards energy consumption is a vital part of our fight against climate change. Engaging people into this issue is the first step towards a social change. However, it has been shown that information campaigns and technology alone are insufficient to achieve such engagement. Understanding what motivate people, in which contexts and combinations, and for which individuals, is therefore key to engaging the public more successfully in such crucial debates. This work investigates the role and impact of motivational strategies on promoting engagement in online energy debates. We report our results from running an experiment in the workplace, in which 33 people contributed to an online discussion on reducing energy consumption. A public and tangible feedback of contributions to the online debate, as well as social comparison and competition were analyzed as motivational strategies. Our results point out that engagement goes beyond intrinsic motivation, and that a set of interplaying factors influenced by the social context was found to be the stronger motivational force of engagement.

Categories and Subject Descriptors

H.5.3 [Group and Organization Interfaces]: Computer-supported cooperative work, Web-based interaction.

General Terms

Design, Experimentation, Human Factors.

Keywords

Engagement, motivation, energy awareness, online debate.

1. INTRODUCTION

The acknowledged power of social media of gathering people around common societal problems is unarguable. However, not all online initiatives are well succeeded, often due to issues of user's engagement and motivation. Engaging participants is a concern that challenges online community managers, designers and sponsors, especially those who aim to exploit the full potential of online tools to promote social change, such as governments, NGOs, and policy makers.

The term engagement can be understood from different but complementary perspectives. Yates and Lalmas [1] define *user engagement* as "the phenomena associated with wanting to use that application longer and frequently", as a result of "the quality of the user experience that emphasizes the positive aspects of the interaction with a web application". Malliaros and Vazirgiannis [2] adopted the definition of "the extent that an individual is encouraged to participate in the activities of a community". When social change is the target, engagement might be also related to the *civic engagement* defined by [3] as "individual and collective actions designed to identify and address issues of public concern.".

From the Web Science perspective, investigating engagement with online tools requires understanding the forces that drive human behavior towards technology, be they individual, social or influenced by the environment. Motivation determines the force and direction of behavior [5], therefore, a crucial aspect towards engagement.

Motivation theories from Social Psychology have the purpose of explaining why people show great effort and persistence on doing things, which may comprehend interacting with a system or being active in a community [5]. This paper is grounded on concepts of the Self-Determination Theory (SDT) [6], which considers that motivation emerges intrinsically for satisfying needs, due to emotion or cognition, and extrinsically, i.e. by means of prizes or rewards. Still, individuals and the environment influence each other supporting or undermining motivation. From the individual side, i.e. psychological needs, interests and values can stimulate engagement with activities and with social groups. The environment, on the other hand, plays a role offering challenges and interesting things to do, providing feedback, imposing goals, and offering opportunities to potentiate the individuals' development [5][7].

This work focuses on understanding the role and impact of motivational strategies on promoting engagement in online energy debates. We build on SDT main elements to evaluate the impact of some motivational strategies not only to promote engagement in terms of online participation but also to connect people to a common issue. Namely, we present a user study in which an online argumentation tool has been used for raising energy awareness and fostering social change towards energy conservation in the workplace. By means of the debate tool, users from a computer science lab discussed about current consumption issues and possibilities to change behavior, building the knowledge collectively and collaboratively.

As expected, the voluntary adoption of this tool by employees required a certain level of motivation, since it was competing in terms of time allocation with other daily obligations. Moreover, the "intangible" aspect of the debated issue can also be seen as an additional challenge to attract people for debating online. This is due to the fact that energy consumption is perceived influenced by habits and environment more than by individual decisions [8][10]

Conference'10, Month 1–2, 2010, City, State, Country.

and, therefore, people may fail to understand how this issue can relate to individual behavior.

Finding ways to engage people with energy consumption towards conservation has been a concern also for governments and police makers, requiring from them the understanding of the behavior change dynamics and motivational strategies to promote it [9][11][12]. Individually, we see engagement as a precursor of behavior change. Collectively, it is the first necessary component leading to a social change.

We hypothesize that engagement with "intangible" issues, such as energy consumption, may benefit from "tangible" feedback to improve users understanding and appropriation of the problem. To test this hypothesis we built the Energy Tree, a public tangible artifact with visual feedback of contributions to the online tool. We added to this analysis the influence of social dynamics of collaborative work and competition on engagement with the online debate.

Composing this exploratory study we:

- Assessed to what extent the presence of the Energy Tree promoted engagement with the energy debate by comparing online engagement during two identical workshops, the first without the tree and the second with it;
- Associated the tangible feedback with social comparison (and the consequent competition) to promote online participation after the workshops, and evaluated qualitatively how they impacted engagement.
- With the lenses of the SDT, analyzed the interplay of intrinsic and extrinsic motivational forces that have led to the engagement in this research scenario.

In the next session we present related works with regard to motivation, online participation and energy awareness/savings. The following session describes the overall methodology, which includes the description of the debate tool and the Energy Tree in terms of features to support the experiment. Then, we describe the experimental setting, which is followed by the results related to online participation and self-assessments. Combining the collected data, we analyze our findings, and subsequently discuss the limitations of the study. We then conclude the paper.

2. RELATED WORK

From the Human-Computer Interaction perspective, Shneiderman [13] sheds light to the current need of better understanding people's behavior, collaborative strategies, engagement, and cooperation to improve social media potential. He illustrates this challenge by underlining the subjectivity and ephemeral aspect of related concepts, such as motivation, an ancient notion that was brought to technology design only recently, according to him.

In [14], Lee et al. evaluated individual achievements, social achievements and gamification strategies in the design of an application that aggregates the Tweets of the employees in a company. Their analysis pointed out that over using motivational strategies (including gamification) may lead the user to lose their intrinsic motivation.

According to Vassileva [15], theories from psychology have been applied in literature to motivate specific behaviors or behaviors change, but not explicitly to motivate a person to contribute to a community. The author analyzed different approaches to motivate participation and found out that money or status rewards may jeopardize the quality of contributions, since people may act for results and not inline with their intrinsic motivations. She also highlights the importance of visualizations and states the need to consider both the user (micro level) and the community model (macro level) for providing incentives. Involving users' real communities beyond the online one is also an important motivational strategy for her.

2.1 Acting socially to promote energy awareness

Working socially to foster energy savings has been a recent approach. According to Pierce and Paulos' literature review in 2012 [16], the vast majority of studies related to energy conservation had been focused on the individual behavior disregarding social changes dynamics. Most of the studies had been evaluated in terms of consumption reduction as a consequence of information provision, either as consumption feedback or by providing hints for saving. A number of initiatives launched by governments and NGO's are found in the literature since the 70's leading to marginal effects on savings [18][19].

Instead of connecting individual's actions to their consequences, as the usual approach, Dourish [20] suggests the need to "connect people through their actions and their consequences", persuading people by the empowerment of collective actions. According to the Climate Change Communication advisory group [21], "there are few influences more powerful than an individual's social network" to promote pro-environmental behavior. People tend to act in a certain way to be in line with others in similar context, following social norms [22]. But just adopting social norms to avoid guilty, or the fear of not 'fitting in' usually produces low level of motivation. When combined with intrinsic motivations, the social norms can be more effective and persistent [21].

Then, studies that associate motivational strategies (social comparison, competition) to engage people via online social networks started to emerge leading to a higher level of savings, such as [23] and [24]. However, factors that contribute to their success are most of the times unclear [25]. Petkov [24] affirmed that users prefer to compare their data against users they know (even if the households present significant differences), suggesting that in the context of real community, such as a working place, this strategy may be even more effective. Welectricity [26] and Opower [27] are examples of online tools that allow users to compare their energy consumption with similar houses.

Competition is a controversial motivational strategy, with some positive results, but yet not so positive effects [19][28] especially when targeting behavior change. In fact, it is found that competition might even encourage the development of unsustainable energy consumption practices [4]. Competition can be associated to rewards, e.g. money or prizes, such as the San Diego Energy Challenge [29]. Although, some authors argue that extrinsic rewards may even undermine intrinsic motivation in some situations [30].

Competition and collaboration can be applied together in different levels, such as teams collaborating internally and competing against each other. A collaborative approach was found in [31], relying on collective savings to reduce the need of energy generation. Projecting consumption data in the street for engaging neighbors to work together is a design alternative evaluated by the authors. Watt-Lite [32] publicly represented statistical data of energy consumption projected on the floor of a factory. It was successful to engage people in the topic when they were close to the installation but not enough visiting the project website afterwards.

Differently from the above-mentioned, evaluating savings or assessing behavior change is out of the scope of this study. We consider engagement as the fundamental step leading to behavior change, and then analyze how engagement in the debate of energy saving issues can be promoted by comparison, competition and public feedback in the context of a working place.

3. METHODOLOGY

In line with [21] and [33], this work relies on the potential of peer-to-peer learning, dialogue and argumentation of different viewpoints to build contextualized knowledge about energy usage. Engaging participants in this collaborative knowledge building process is the first step towards fostering longer-term changes.

For promoting engagement, we designed the Energy Tree, a public tangible artifact with visual feedback of contributions to the online tool. We combined face-to-face group activities with online participation to explore the impact of the Energy Tree on participants' engagement with the online debate on energy conservation. The methodology comprehended qualitative analysis applied to:

1) **The assessment of the impact of tangible and public feedback on engagement.** Two identical workshops promoting the online debate, one with and the other without the Energy Tree were conducted. Resulting contributions to the online debate associated to self-assessment questionnaires provided data for the analysis of the role of the tangible feedback on engagement.
2) **Evaluation of the tangible feedback associated to social comparison dynamics.** After the workshop, the Energy Tree was placed in a public area providing feedback of new contributions for both workshop groups, alternately, for 10 days. The impact of comparing group performances by means of the tree was evaluated supported by a sample interview with the top contributors and people who completely stopped contributing after the workshop.
3) **Analysis of motivational forces considering intrinsic and extrinsic sources.** Participants of the first workshop, the one without the tree, were told about a prize (no money related) that would be offered to the top contributor, adding an extrinsic motivation element to the study. The analysis of the motivational forces, intrinsic and extrinsic, on engagement took into account the main elements of the Self-Determination Theory. Qualitative study of contributions to the online debate, self-assessments responses and outcomes of interviews subsidized the analysis.

How this methodology was applied to this experimental setting is further detailed. The experiment relied on the adequacy of the technical artifacts, both the debate tool and the Energy Tree, in providing features that motivate engagement. In the next sessions we describe how these artifacts were conceived and configured to support this study.

3.1 The debate tool

Energy saving and behavioral change are complex domains to be discussed, in which there are no right answers, or unique world views. Then, a debate tool must be featured to provide the expected contrast and connections of opinions. The Evidence Hub is a kind of Contested Collective Intelligence Platforms [34] applied to this study, suitable to support the complexity of discussion domain.

As an argumentative knowledge construction tool [35], instead of leading to find the best and quickest answer to a question, the Evidence Hub promotes the development of critical thinking and collective assessment of several solutions in order to support a higher-level reflection on the different aspects of a debate.

Users can create **issues**, and **ideas** that overcome issues. Both issues and ideas can be supported or challenged by **arguments,** promoted by **votes for** and demoted by **votes against**. Users can also add **Facts** or Web **resources** to enrich the debate. Figure 1 illustrates a Knowledge Tree connecting an Issue to Ideas, Arguments and Facts.

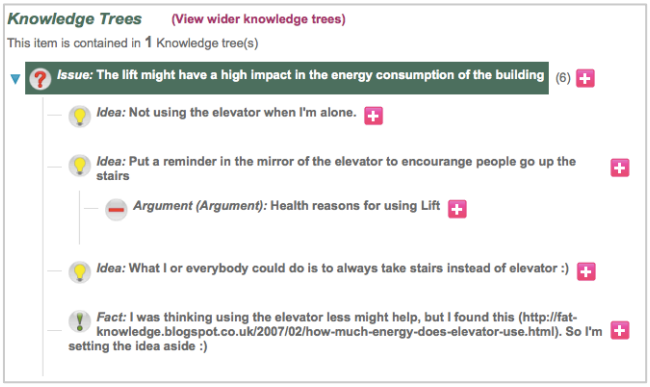

Figure 1 – Screenshot of a knowledge tree in the Evidence Hub

Based on the nature of the content expected to be generated by participants, the Evidence Hub was set up with six main themes to debate on: 1) Behavior Change; 2) Consuming Energy, mostly issues about how energy has been used and eventually wasted; 3) Environmental Impact; 4) Good Practices, a theme that emerged for need of sharing the good behaviors that people already had; 5) Institutional Actions, identifying constraints associated to the building or to the institution, therefore out of individual control; and 6) The Tree – a space for ideas of how to apply the tangible device for the experiment.

Besides navigating content by tags, key challenges or type of contribution, users can also explore the map of connected people and ideas. Figure 2 illustrates the dynamic social network visualization. By means of this polarized semantic map, users can identify those who they mostly agreed, disagreed or expressed neutral comments within the conversation. The colors green, red and grey represent these levels of connections.

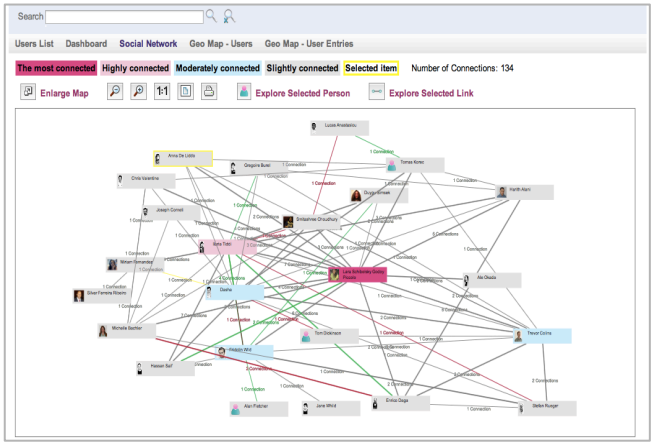

Figure 2 – Screenshot of the users connection map

The Energy Tree was connected to the Evidence Hub database to provide a visual feedback of the number of contributions to the

online debate. In the next section we describe the Energy tree functioning and its expected role to promote engagement.

3.2 The expected role of the Tree

Technically, the Energy Tree is a led-lights tree (Figure 3) designed to be solar powered, with seven branches that illuminate independently. It was developed upon the Microsoft Gadgteer Fez Spider Kit and connected to the Evidence Hub in such way that every 60 new user-contributions to the tool lighted on a new branch of the tree.

Figure 3 - The Energy Tree

Conceptually, it is a Socially-inspired Energy-Eco-Feedback Technology [36] [37], conceived to promote new patterns of behavior (social affordances) within a social group [38] by promoting the connection between energy consumption and natural environment impact.

The Energy Tree was conceived to be a motivational artifact. In Table 1, we describe how the tree and the debate tool together are featured to promote motivation according to a set of ten design principles for *motivational affordances* [39]. These motivational affordances, which are also based on the SDT main concepts, refer to properties of objects that determine whether and how they can support one's motivation, considering psychological needs, cognition, social needs, and emotion as possible sources of motivation [39].

Table 1 – The Energy Tree and Evidence Hub features related to motivational design principles [39]

Design principles	Features
Psychological needs 1. Support autonomy 2. Promote creation and representation of self-identity	- Users of the debate tool have their profile with pictures. - The Energy Tree represents results of a pre-established group of users.
Cognition 3. Design for optimal challenge 4. Provide timely and positive feedback	- The target established to light on the tree was previously calculated to be feasible, but not too easy to achieve. - The tree provides instant feedback of new contributions.
Social and Psychological needs 5. Facilitate human-human interaction 6. Represent human social bond 7. Facilitate one's desire to influence others 8. Facilitate one's desire to be influenced by others	- Being publicly displayed, the tree aims at promoting collaboration among participants towards lightening it on completely. - It has also the intended role to trigger online and real discussions about energy consumption. - The debate tool provides visualizations of people connected by their content (Figure 2). - By voting and arguing, users can explicit support or oppose others' idea.
Emotion 9. Induce intended emotions via initial exposure to ICT 10. Induce intended emotions via intensive interaction with ICT	- The tree was designed intending to be visually attractive, calling people's attention and reminding them about the current energy awareness initiative [43]. - The novelty aspect of a tangible feedback can be considered as a motivation.

The Energy Tree was originally conceived as a tangible feedback of group energy savings [36][37], but the need to first promote engagement has lead to a change in the design. How the tree was applied in the experimental setting is described below.

4. EXPERIMENTAL SETTING

The study took place in a research university department in the UK during October-November of 2013. Four phases shaped the experiment that together implemented the methodology. The phases are:

1) Online survey. Aimed at collecting initial perceptions about how energy has been consumed in the lab and preliminary ideas for behavior change. The participation was opened to everyone in the department by means of an online form with three simple questions. The results of the online survey were then used to pre-seed the Evidence Hub with meaningful content, thus providing a useful starting point for the online debate.

2) Two workshops (WS1 and WS2) were organized to promote the online debate by gathering volunteers to use the Evidence Hub. The two workshops had the same dynamic, except by the presence of the Energy Tree in WS2, making it possible to compare results and infer about effects of the Energy Tree on engagement. The Energy Tree was centrally located as a feedback mechanism during WS2 by reflecting the number of new submitted contributions. Each workshop lasted 2 hours and was run in a meeting room. Participants were asked to create, promote or demote Facts, Arguments, Issues, and Ideas online. Some face-to-face discussions enriched the online debate, but most of the time participants interacted individually with the online tool. The content generated in the WS1 was not visible for the participants of the WS2 to avoid influence. For assessing possible effects of extrinsic motivation on engagement, participants of WS1 only were told about a non-monetary prize (indeterminate) that would be offered to the top contributor in the end of the study.

After interacting, the attendees completed usability and motivational assessments.

3) 10 days of online debate. For evaluating motivation and, complementary to the workshop dynamic, "spontaneous" engagement with the debate, Group1 from WS1 and Group 2 from WS2 were asked to continue contributing to the online debate for 10 days, each group contributing to a different website. During that time, participants could optionally make use of energy monitoring devices for learning and sharing knowledge about individual consumption. The Energy Tree was placed in a social area as a feedback of engagement. Every 60 new contributions to the tool (new issues, ideas, arguments, facts, resources or votes) turned on a new branch of the tree. Results of each group were identified by a sign and kept alternating from time to time. The competition between groups was not clearly promoted.

4) Sample interview. To understand what motivated participation, perceptions, as well as their overall experience towards this study, a sample of participants that included the top and bottom contributors was interviewed.

4.1 Motivational assessments

We applied two self-assessments artifacts to workshop attendees aiming at finding qualitative evidences of potential motivational forces related to engagement:

- The Self-Assessment Manikin – SAM [40] was applied to evaluate the affective quality of the interaction with the debate tool, potentially under influence of the Energy Tree for Group 2. It consists on a pictographic questionnaire that assesses three dimensions of emotions: valence, the positive or negative feeling caused by the experience; arousal that means the level or excitement or boredom; and dominance, in this case, it means the perception of control interacting with the Evidence Hub.
- Intrinsic Motivation Inventory (IMI) [41]. This questionnaire is part of the SDT framework. We applied the shortest version with 9 items consisting of three subscales: *Interest/enjoyment* that measures the intrinsic motivation directly; *Perceived competence*, a positive predictor of motivation related to how adequate the interaction was to participants' skill; and *Pressure/tension*, a negative predictor of intrinsic motivation related to external factors. Lower values are preferable for this subscale. Usually the IMI is applied to larger samples making it possible to explore correlations statistically. In this limited research scenario, the IMI was applied to point directions of the eventual impact and influence on intrinsic motivation.

4.2 Calculating contributions

Voting clearly requires less effort from the Evidence Hub user when comparing to the action of creating a new idea or issue, for example. For this reason, a system of points was established to calculate participation and identify the top contributors. Any new Idea, Issue, Fact or Web Resource value 3 points; Arguments value 2 points and votes 1 point each.

5. RESULTS

Numbers related to participation and self-assessments are presented here, supporting the qualitative analysis and discussion in the next session.

5.1 Participation

The four phases of the study involved a total of 33 participants, most of them researchers and some PhD students of the computer science lab. The workshops gathered 24 voluntary participants (12 people per workshop), including 10 of the 19 respondents of the online survey.

The total of contributions generated in the debate tool is synthetized in the chart in Figure 4. Group 1 generated less contributions in the workshop (348) compared to Group 2 (542), which had the tree. The score inverted when the tree was installed in the public area as a feedback of contributions for both groups alternately (phase 3). Group 1 created 247 new contributions and Group 2 only 78. These numbers suggest that the Energy Tree had a potential impact on participation when seen as a novelty. This result though must be associated to other assessments and variables to be conclusive.

In terms of type of contributions among votes, ideas, issues, arguments, facts and resources, both groups had comparable distribution as represented by the chart in Figure 5. These distributions can be considered adequate for the debate balance, such as the higher number of ideas than issues, as well as the expected high number of votes, which reflects that users accessed other people's contribution and expressed their opinion.

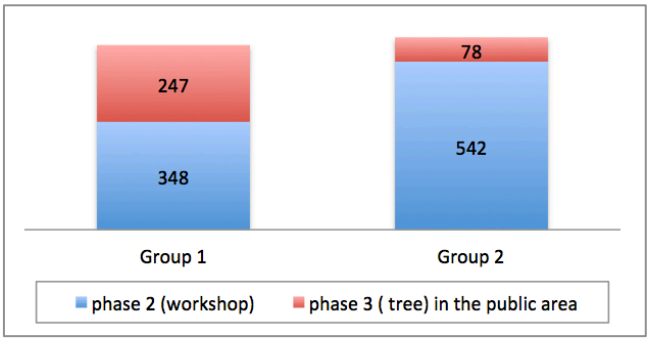

Figure 4 - Contributions to the debate tool per group

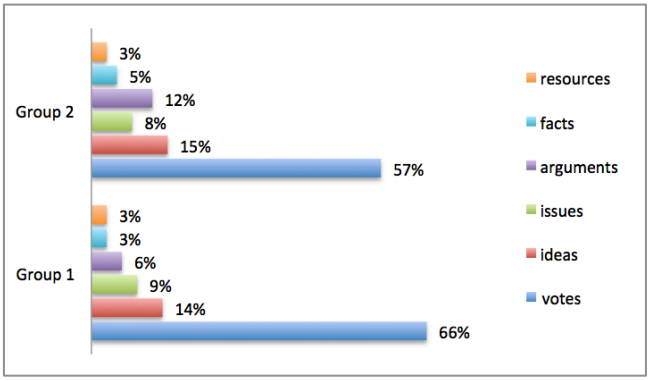

Figure 5 - Distribution of types of content in the debate

The most significant distinction between the groups is the number of arguments created by Group 2, twice as many posted by Group 1, possibly reflecting a characteristic of the group.

The main challenge of promoting engagement was keeping people motivated to access the debate tool during the phase 3, after the workshop. The chart in Figure 6 illustrates the number of contributions day by day during this phase. The number remained stable between D3 (Friday) and D7 (Tuesday), when an external intervention occurred: an email ranking results of both groups was launched. Just after that, the number of Group 1 contributions increased 37% (59 new posts) and 201% (31 new posts) for Group 2. The score was published again on D8 and D10 also reminding participants about the last day of the study. The last increased the participation once again in 9% for Group 1 and 70% for Group 2.

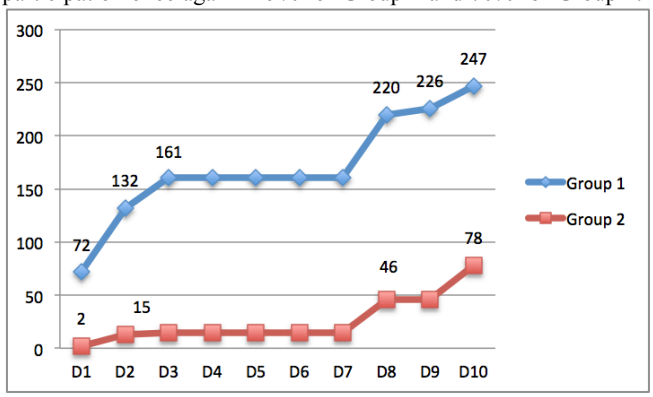

Figure 6 - Contributions generated per day

5.2 Assessments and sample interview

Figure 7 presents comparative results of the affective quality assessment [40] regarding to valence, motivation, and dominance. These aspects were scored from 1 to 5, in which 5 is the most

positive answer. Participants of WS1 demonstrated slightly more positive perception (valence). The average was 4.26 for Group 1 and 3.83 for Group 2. Despite of being differently distributed, the mean of motivation was identical, 4 for both groups. Dominance was the aspect worst scored with 2.6 of average for Group 1 and 3.0 for Group 2, suggesting that people from both workshops felt a bit too challenged when interacting to the debate tool.

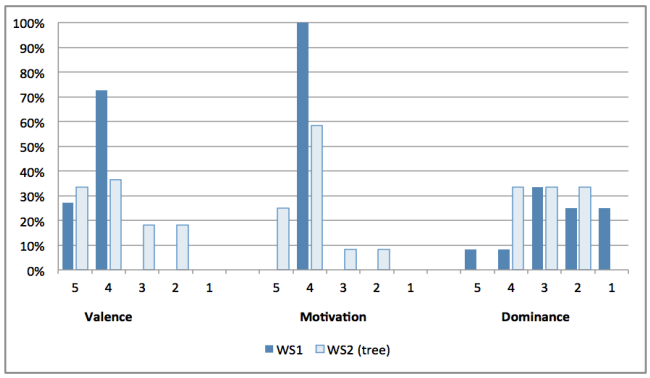

Figure 7 - Results of the SAM

The concepts related to motivation were scored from 1 to 7 in the IMI [41]. The results presented in Table 2 are statistically limited (high standard deviation) due to the small sample of this study, but it suggests higher motivation by participants of WS1 than WS2, which had the tree. The competence subscale results are proportionally comparable to the dominance assessment by the SAM [40]. Both groups expressed having an autonomous behavior at a certain degree by the low score of Pressure/Tension.

Table 2 – Results of the IMI

		Mean	Median	Mode	SD
Interest/ Enjoyment	G1	**5.22**	5.00	6.00	1.20
	G2	4.60	5.00	5.00	1.42
Perceived competence	G1	**4.67**	5.00	6.00	1.78
	G2	4.13	4.00	4.00	1.62
Pressure/ Tension	G1	2.25	2.00	1.00	1.72
	G2	2.25	2.00	1.00	1.36

Details of the usability evaluation of the Evidence Hub are out of the scope of this paper. However, how participants perceived the online tool might influence engagement and motivation. The Table 3, thus, summarizes the average score (from 1-5) of positive and negative usability aspects by both groups, pointing out that Group 1 had a better perception in terms of the ease of leaning and use, complexity, etc. The complexity was the main issue pointed out by participants.

Table 3 - Summary of usability evaluation

Usability aspects	Group 1	Group 2
Positive	3.40	2.96
Negative	2.15	2.42

As part of the usability assessment, when asked about the effectiveness of the Evidence Hub to raise energy awareness, workshop participants highlighted mostly aspects related to debate, as enumerated in Table 4.

Table 4 – Mentioned aspects of the debate tool that contribute to energy awareness and % of answers that refers to it

The informative aspect, new ideas, knowledge sharing	44%
The debate elements (contrast opinion, arguments)	31%
It made me think	6%
Potential to organize a community around a problem	6%
Connecting ideas	3%
Funny	3%
The tree as motivational aspect	3%
Goes from discussing issues until finding solutions	3%

Nevertheless, one participant pointed out his/her dissatisfaction by saying: "*I would prefer to search Google/newspaper for facts and reports rather than view other people's claim / notes*". This particular participant also reported the lowest level of intrinsic motivation (2.8) for using the debate tool.

The interview with a sample of participants revealed aspects related to their overall experience towards the study. Regarding reasons to participate, respondents were asked to choose up to tree reasons to be engaged in this study. The results are quantified in the chart (Figure 8), evidencing that the tree was the second main reason for participating, more than all other technical artifacts or the social aspect of the activities.

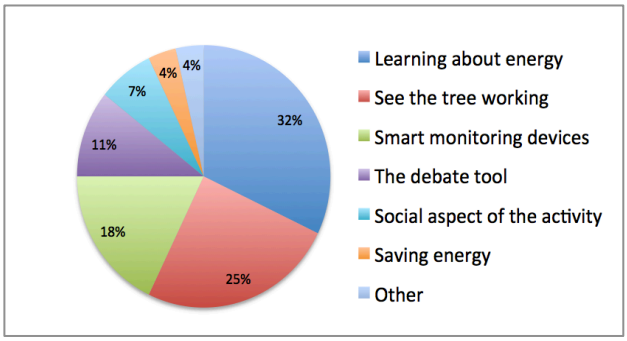

Figure 8 - Reasons to be part of the study (chosen among a set)

Interviewees also scored (1 to 5) the level of attention they spent to the tree during the WS2 and during the time it was installed in the public area. The average score of attention in the workshop by Group 2 was 3.5, while in the public space was higher, 3.9. Figure 9 represents the score distribution.

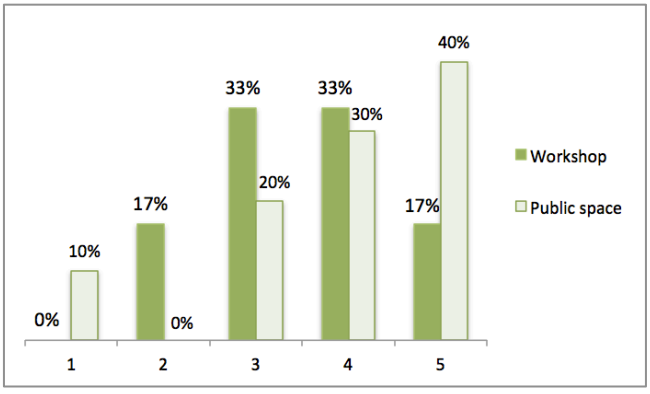

Figure 9 - Score of the level of attention to the tree

Table 5 relates a sample participants' data, including the top 2 contributors of each group, plus one person of each that did not

contribute at all after the workshop. Data from different sources were associated: the user's participation in points, as described in the section 4.2, the Interest/enjoyment subscale of IMI score, the stated main reason for being part of the activity, and the meaning of the tree for them when they used to see it in the public space.

Table 5 - Cross data of a sample of participants

		Points	Interest / enjoy-ment	Main reason for contributing	The tree meaning
Top 1	G1	244	6.20	Learning	The progress, competition
	G2	99	5.40	Environmental	Competition
Top 2	G1	99	4.60	Learning	Competition
	G2	58	4.80	Learning	Guilty
No participation	G1	34	5.20	Social aspect of the activity	Someone is doing
	G2	12	4.80	Learning	Guilty

From this group of interviewees, only the G1 participant that did not contribute admitted to not have changed any behavior as a consequence of the study. All the others mentioned examples of changes both at the workplace and at home, suggesting the positive effect of the study in raising awareness, i.e., referring to longer-term changes in behaviour: "*I am more attentive to energy consumption in general and whenever I have the chance in the future, energy consumption of devices I purchase will play a more important role"*. And *"I recently got a table lamp and use it instead of the main lights when I am alone in the open space)",* referring to changes in the workspace.

6. ANALISYS

By connecting results from the Evidence Hub, self-assessments and the sample interview, we analyze and discuss the impact of the tangible device, as well as the effect of social comparison and competition on engagement. Then, we analyze results taking into account the main SDT concepts.

6.1 The tangible device effect

Results of self-assessment pointed out higher level of motivation (Table 2) and a better perception of the tool by participants of Group 1 (Table 3). However, Group 2 produced 56% more during the workshop, as illustrated by the chart in Figure 4, evidencing the impact of the tangible device on participation. The Energy Tree was also declared as the second reason for people to be engaged in the study, more than the smart monitoring device and the debate tool (Figure 8).

However, the presence of the tree in the public area was not enough to keep Group 2 participants engaged. A possible explanation is that the novelty aspect of the technology, which may increase motivation, was not present anymore for this group that had already lighted on the Energy Tree completely beforehand, during the WS2.

In the workshop, the effect of the tree could be even stronger if there was no pre-established goal to light it on, which was perceived as a limit by workshop attendees. When the tree was completed, and the last branch was lightened, typical reactions from the participants were: "*and now*?", and "*we don't need to contribute more*". Similar effect of loosing motivation was observed in on-line communities where users had to achieve a goal to have access to new features [42]. Design alternatives to go beyond the goal - more levels of contributions represented by unexpected lightening effects, for instance, should have overcome this constraint.

Placed in the public area, the visual feedback of the tree was more effective in attracting participants' attention (Figure 9). Differently from the workshop, in which people spent most of the time working online, in the public space the tree was considered mainly a reminder that the study was going on, as suggested by our previous analysis with regard to energy awareness [43].

The expected effect of the artifact leading to new patterns of behavior was identified as a post to the debate tool: "*It looks like thanks to the tree we started switching off the lights during the day*", however, this effect could not be identified by the sample interview, in which the tree was said to be perceived mostly as signal of competition or guilty for those who were not collaborating, as further described.

6.2 Social comparison and competition

Learning about energy was stated by participants as the main reason to engage with the study (Figure 8). We see comparison as central aspect in a collective learning process, for this reason social comparison has not been evaluated in terms of effectiveness in this study.

The debate potentiates the comparison not only in terms of number of posts created, but also by the possibility to contrast opinions. Participants highlighted these aspects positively when discussing about the effectiveness of the tool to raise awareness in Table 4, as well as they made evident the value of arguments and the possibility to see connected people and ideas.

The public feedback by the Energy Tree was also a tangible way to provide social comparison both within the groups and especially between them. A participant from Group 1 declared to think that "*some people are saving energy*" when seeing the tree in a public place, meaning that him/herself was not contributing, although the group result was evident.

As also stated in [43], making public results of both groups changed the perceived meaning of the tree for them: the group with better result mostly associated the tree with a feedback of their performance (including competition), while for the Group 2, the tree was a signal of guilty: - *" it's like I am not fulfilling my responsibilities*", declared a Group 2 interviewee.

Social comparison is actually a predictor of competition, which was reported as an important trigger for the most engaged people in Table 5. The Group 1 second contributor said about his/her thoughts when seeing the tree in the public space: "*Shamelessly competitive: Is my group doing best?*". Another important aspect to be highlighted is that the both top contributors claimed for a public reward.

Comments during the WS2, such as "*Does the tree refer to everyone*?", expressing disappointment, and "*We should compete against each other!*" illustrate the preference for the competition approach instead of working collaboratively.

In terms of number of contributions, the curve associated to daily contributions in (Figure 6) made clear that the first intervention of publishing the ranking of both groups' contributions on D7 impacted participation. The importance of competition stated by the top contributors suggests that the ranking had a motivational meaning. The same effect of the intervention was not observed in

the following day though, suggesting that the frequency of interventions must be carefully planned to be effective.

In terms of quality of contributions, the controversial effects of competition found in the literature, such as cheating and loosing the quality [28], were not confirmed in this research scenario. Group 1 had a higher number of votes. For being the simplest way to interact to the system, it can be considered as a consequence of the individual prize offered for the Group 1. However, voting is also a relevant way to promote the debate, so, in this context, it cannot be seen as cheating or quality loss.

Despite of presenting the highest level of intrinsic motivation towards the debate tool during the workshop, the top contributor also declared the interest by the competition, prize and reward, suggesting that the intrinsic motivation was not the only responsible for the engagement.

6.3 Motivation and engagement

Satisfying a need leads to well being, for this reason Autonomy, Competence, and Relatedness are considered the most important needs that lead to intrinsic motivation according to SDT [5][7].

More **Autonomy** means stronger motivation. The behavior is said to be autonomous (or self-determined) when in line with one's interests, preferences and wants; otherwise, external forces, like pressure, guide it. **Competence** reflects the interest in applying and developing our skill performing a task; to enhance intrinsic motivation, competence must be accompanied by autonomy. **Relatedness** refers to the need to establish close emotional bonds with other people. Relatedness may also be a reason to internalize extrinsically motivated behaviors, since people are willing to have the behaviors valued as significant by others to whom they want to be connected, whether a family, a peer group, or a society [6].

Autonomy

As voluntary participation, contributing to the online debate relies on autonomous behavior, which in turn is related to intrinsic motivation, interest, and enjoyment. Individually, intrinsic motivation measurements could not be directly associated as an indicator of engagement in this research scenario. People who did not keep contributing after the workshop had similar or even higher level of intrinsic motivation than people among the top contributors (Table 5).

However, the novelty aspect of the Energy Tree seemed to promote initial engagement, leading to a higher number of contributions to the debate tool in the first contact of users with the tangible technology.

Competence

In this study context, competence was mainly related to the perception of usability aspects of the tool, declared to be complex by users. The Group 1 participants' higher intrinsic motivation (and perceived competence) seems to be associated to the experienced affective quality (Figure 7), also higher in average. They better evaluated the tool in terms of usability than participants of WS2, with the tree.

Low levels of competence may prevent users to adopt a tool after the first contact. Although usability aspects are out of the scope of this paper, the adequacy of the online solution to the user skills and expectation must be ensured to motivate engagement. Results pointed out that the group with higher competence continued contributing, but it is not possible to affirm that it happened due to this correlation, since the presence of the tree, as describe below, had others more evident influence.

Relatedness

By far, relatedness is the strongest motivational aspect in this experimental setting that relies on a collective platform. Elements associated to the debate such as argumentation, contrast of opinions, support or opposition to others' contribution, were mentioned as strengths for promoting energy awareness, as describe in Table 4.

Competition and public reward played an important role on engagement of those who most contributed to the online debate, demonstrating the importance of human bonds and social influence. Differently from reported by [37], a study that also evaluated the Energy Tree in the context of an elementary school, competition did not affect the quality of contributions. A possible explanation refers to the social context; in a working environment, people tend be more careful about preserving their image.

The consequent changes in behavior declared by most of the interviewees suggest the effectiveness of this experimental setting to raise energy awareness. Associated, intrinsic and extrinsic reasons together strengthened motivation and promoted engagement.

7. Discussion

Vassileva [15] states that relating motivation and online community engagement requires dealing with the influence of external factors that may lead to unpredictable behavior by the participants. We argue that the methodology and the experiment design must consider alternatives to overcome possible influences created by the environment. In the context of a workplace, for example, hierarchical pressure for participation or the lack of institutional support could bias results of engagement. In this research scenario, we did not detect unpredicted behavior, possibly due to the controlled and familiar environment where the experiment took place, its short-term run, and the relatively small number of participants.

These characteristics made it difficult to statistically analyze the impact of our motivational strategies on online engagement. Despite all that, qualitative results pointed out some interesting directions with regards to:

- **The tangible feedback of contributions**: the presence of the Energy Tree promoted engagement in a situated interaction (the workshop), possibly due to the novelty aspect of it. When placed in a public space, the artifact was mostly perceived as a reminder of the study.
- **Social comparison and competition**: even though competition was not strongly promoted, the top contributors in the study declared it as an important motivational force behind their engagement. No negative aspects were reported or found to be associated with competition in this research scenario.
- **Intrinsic and extrinsic motivations**: engagement could not be explained by intrinsic motivation alone. The top contributors requested public rewards as well as declared their interest in the prize, suggesting that intrinsic and extrinsic motivations must be combined to promote engagement.
- **Characteristics of the online debate**: participants evaluated the debate as effective to raise energy awareness due to the possibility of comparing and contrasting their opinions and ideas.

As an exploratory study, we mixed some motivational strategies, such as the presence of the Energy Tree and social comparison/competition, thus making it more difficult to evaluate

the potential impact of isolated strategies. However, studying the impact of multiple interplaying strategies is the focus of this work, which is also supported by the literature on behavior change which argues for using a combination of motivational strategies to engage people more effectivly [11].

Vassileva [15] argues that results associated with successful incentives in one community cannot be easily generalized to other communities. The users in our study were all computer science researchers, wich limits our ability to generalise our findings to other user groups. Nevertheless, our results can act as pointers to further research directions, and to experiments involving a wider variety of users.

8. CONCLUSION

This exploratory study analyzed motivational strategies related to the engagement of users with online debate on energy saving. A public tangible feedback of online participation was proposed as a motivational strategy. The impact of this device on engagement and how the social dynamic of competition and collaboration influenced participation were analyzed qualitatively.

In the context of this research scenario, external factors were found as positively impacting engagement. While scores of intrinsic motivation alone could not suggest engagement, competition and public reward were mentioned as crucial for those participants who most contributed.

Possibly due to the novelty aspect associated to the device, which attracted participants' curiosity, the Energy Tree was effective on promoting situated engagement. However, placed in a public area, the presence of the tree promoted competition between groups of users, and worked as a symbol, a reminder of the ongoing energy awareness study.

For promoting Relatedness, one of the most important needs that lead to motivation, participants judged the Evidence Hub as effective to raise awareness and highlighted debate elements (arguments, contrasting opinion) as the strengths. These elements of collective knowledge building are important to promote engagement not only in terms of online participation, but also to establish and promote new social norms, leading to a desired social change.

In the Web Science perspective, our results contributed to the understanding of the relationship between motivation, a force that drives behavior, and engagement with an online tool. Even though situated, the findings point directions to further investigations in different research scenarios.

9. ACKNOWLEDGMENTS

The authors thank CAPES (PDSE program) – process 3355/13-6, Green Energy Options (GEO), the UNICAMP, Microsoft Research, DecarboNet (FP7 program – grant agreement 265454), and Catalyst (FP7 program - grant agreement #6111188).

10. REFERENCES

[1] Yates, R. B., Lalmas, M. 2012. User engagement: the network effect matters!. In *Proc.of the 21st ACM Intl. conference on Information and knowledge management (CIKM '12)*. ACM, New York, NY, USA, 1-2.

[2] Malliaros. D. F., Vazirgiannis, M. 2013. To stay or not to stay: modeling engagement dynamics in social graphs. In *Proc. of the 22nd ACM international conference on Conference on information & knowledge management (CIKM '13)*. ACM, New York, NY, USA, 469-478.

[3] American Psychological Association. Civic Engagement. http://www.apa.org/education/undergrad/civic-engagement.aspx

[4] Brewer, R.S, Lee, G. E., Johnson, P. M. 2011. The Kukui Cup: a dorm energy competition focused on sustainable behavior change and energy literacy. In *Proceedings of the 44th Hawaii Intl. Conf. on System Sciences*, January 2011.

[5] Reeve, J. 2009. *Understanding Motivation and Emotion*, 5th ed. Hoboken, NJ: Wiley.

[6] Deci, E. L., Ryan, R. M. 1985. Intrinsic Motivation and Self-Determination in Human Behavior. NY: Plenum.

[7] Piccolo, L.S.G., Baranauskas, M.C.C. 2012. Basis and prospects of motivation informing design: requirements for situated eco-feedback technology. Proc. of the 11th Brazilian Symposium on Human Factors in Computing Systems (IHC '12). SBC, Brazil, 137-146.

[8] Pierce, J., Schiano, D.J., Paulos, E. 2010. Home, habits, and energy: examining domestic interactions and energy consumption. *Proc. of CHI '10.* ACM, 1985-1994.

[9] EEA (European Environment Agency). 2013. Achieving energy efficiency through behaviour change: what does it that? Technical Report N5/2013.

[10] Jelsma, J. 2006. Designing 'Moralized' products: theory and practice. *User Behaviour and Technology Development*, Verbeek, P-P. and Slob, A. (eds) Springer, 221–231.

[11] Houses of Parliament. 2012. *Energy Use Behaviour Change*. N 417. http://www.parliament.uk/briefing-papers/POST-PN-417.pdf

[12] Darnton A. 2008. GSR Behaviour Change Knowledge Review. *Reference Report: An overview of behaviour change models and their uses,* HMT Publishing Unit, London. http://www.civilservice.gov.uk/Assets/Behaviour_change_reference_report_tcm6-9697.pdf

[13] Shneiderman, B. 2011. Technology-mediated social participation: the next 25 years of HCI challenges. *In Proceedings of HCII'11*. Vol. Part I. Springer, 3-14.

[14] Lee et al. 2013. Experiments on Motivational Feedback for Crowdsourced Workers. *In Proc. of the 7th International AAAI Conference on Weblogs and Social Media.* http://www.aaai.org/ocs/index.php/ICWSM/ICWSM13/paper/view/6118

[15] Vassileva, J. 2012. Motivating participation in social computing applications: a user modeling perspective. User Modeling and User-Adapted Interaction, April 2012, V 22, Issue 1-2, 177-201

[16] Pierce, J., Paulos, E. 2012. Beyond energy monitors: interaction, energy, and emerging energy systems. In *Proceedings of* CHI '12. ACM, 665-674.

[17] Froehlich, J., Findlater, L., Landay, J. 2010. The design of eco-feedback technology. *Proc. of CHI '10*. ACM, 1999-2008

[18] Abrahamse, W. et al. 2005. A Review of Intervention Studies Aimed at Household Energy Conservation, *Journal of Environmental Psychology*, 25(3), 273-291.

[19] Froehlich, J. et al. 2012. The design and evaluation of prototype eco-feedback displays for fixture-level water usage data. *Proceedings of CHI'2012*, 2367-2376.

[20] Dourish, P. 2010. HCI and environmental sustainability: the politics of design and the design of politics. In *Proceedings of the DIS '10*. ACM, 1-10.

[21] Climate Change Communication Advisory Group. 2010. *Communicating climate change to mass public audiences.* Public Interest Research Centre. http://psych.cf.ac.uk/understandingrisk/docs/cccag.pdf

[22] Goldstein, J. N., Cialdini, R. B., Griskevicius, V. 2008. A Room with a Viewpoint: Using Social Norms to Motivate Environ. Conservation in Hotels, *Journal of Consumer Research*, Oct, 2008.

[23] Foster, D. et al. 2010. Wattsup?: motivating reductions in domestic energy consumption using social networks. In *Proc. of the NordiCHI '10*. ACM, New York, 178-187

[24] Petkov, P. et al. 2011. Motivating domestic energy conservation through comparative, community-based feedback in mobile and social media. In Proc. of the 5th Intl. Conf. on Communities and Technologies. ACM. 21-30

[25] Dillahunt, T., Mankoff, J. 2014. Understanding factors of successful engagement around energy consumption between and among households. Proc. of the 17th Intl. conf. of the Computer Supported Cooperative Work and Social Computing Conference (CSCW'14), 1246-1257.

[26] Welectricity. http://welectricity.com/

[27] Opower. https://social.opower.com

[28] Johnson, P.M. et al. 2012. Beyond kWh: Myths and Fixes for Energy Competition Game Design. *Meaningful Play Conference*. East Lansing, USA.

[29] San Diego Energy Challenge. https://www.sdenergychallenge.com

[30] Kersten, G., Wu, S., Oertel, C. 2011. Extrinsic or Intrinsic Motivation of E-Negotiation Experiments' Participants. In *Proc. HICSS' 2011*, IEEE (2011), 1-10.

[31] Boucher, A., Cameron, D., Jarvis, N. 2012. Power to the people: dynamic energy management through communal cooperation. In *Proc. of the Designing Interactive Systems Conference (DIS '12)*. ACM, 612-620

[32] Jönsson, L., Broms, L., Katzeff, C. 2010. Watt-Lite: energy statistics made tangible. *Proc. of the 8th ACM Conference on Designing Interactive Systems DIS '10*, 240-243

[33] Concannon S., Healey P.G.T. 2013. Social Media for Social Change? *CHI 2013 Workshop Designing Social Media for Change*, Paris, France. http://socialmedia4change.org/concannon/

[34] De Liddo, A., Sándor, Á., Buckingham Shum, S. 2012. Contested Collective Intelligence: Rationale, Technologies, and a Human-Machine Annotation Study. *Computer Supported Cooperative Work*, 21, 4-5, 417-448. http://oro.open.ac.uk/31052

[35] De Liddo, A., Buckingham Shum, S. 2013. The Evidence Hub: harnessing the collective intelligence of communities to build evidence-based knowledge. Large Scale Ideation and Deliberation Workshop, *6th Intl. Conference on Communities and Technologies (C&T2013)*, Munich, Germany.

[36] Piccolo, L.S.G., et al. 2013. Designing to Promote a New Social Affordance for Energy Consumption. In *Proc. of 12th IFIP Conf.on e-Business, e-Services, e-Society.* (I3E' 2013). 213-225.

[37] Piccolo, L.S.G., Baranauskas, C. Azevedo, R.J. 2014. Evaluating an Energy Feedback Technology in a Social Developing Scenario. *Paper submitted.*

[38] Stamper, R.K. 1973. Information in Business and Administrative Systems, John Wiley and Sons, New York

[39] Zhang, P. 2008. Motivational affordances: Reasons for ICT design and use, In Communications, ACM, vol 51, nº11.

[40] Bradley, M., Lang, P. 2000. Measuring emotion: Behavior, feeling, and physiology. *Cognitive neuroscience of emotion*. NY: Oxford University Press, 242–276.

[41] Intrinsic Motivation Inventory, http://www.selfdeterminationtheory.org/questionnaires/10-questionnaires/50

[42] Mamykina, L. et al. 2011. Design lessons from the fastest Q&A site in the west. In *Proc. of CHI '11*. ACM, New York, NY, USA, 2857-2866.

[43] Piccolo, L.S.G. et al. 2014. Energy Consumption Awareness in the Workplace: Technical Artifacts and Practices. *Paper submitted.*