A Field Experiment on Using Messaging and Virtual Rewards to Increase User Participation on NanoHUB.org*

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Abstract

We conducted an experiment with 30,000 users of a virtual nanotechnology facility, *nanoHUB.org*. We investigate the effect of virtual points and message framing on user participation in a survey. In one treatment, users receive points for completing the survey. In another treatment, users are exposed to a visual observation cue. We vary the social message, either emphasizing the private benefit to the user or the social benefit to the community of participation. Participation rates are increased through virtual points and for users receiving the private benefit messaging. The observation cue doesn't have an effect.

JEL Classifications: C72, C91
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1. Introduction

Online communities, such as discussion groups, question and answer markets, and collaborative workgroups are important sources of information sharing, knowledge generation and social support for individuals. Many of the most popular online communities could not exist without sufficient user-contributed content; in fact, online communities often fail due to under-contribution (Beenen et al., 2004). To shed light on different approaches that may encourage greater participation in online environments, we conducted a field experiment in the world's largest virtual nanotechnology user facility, *nanoHUB.org*, which serves over 12,000 registered and 260,000 unregistered users annually. *NanoHUB.org* is an organization-sponsored community in which users maintain a professional relationship (Klimeck et al., 2008; Strachan et al., 2010).[1] Similar to most online communities, the success of *nanoHUB.org* and other science and engineering *HUBs*[2], depend on user-contributed content.

Our field experiment was designed to investigate several different approaches to motivate users to contribute to this community. 30,000 registered *nanoHUB.org* users were randomly selected into several treatment groups, and received e-mails soliciting their voluntary participation in an online survey. Participation in the survey benefits the user, fellow community members and the host of the community, because user input is used to improve the site and secure future funding. Similar to contributions of content to the site, participation in the survey constitutes a public goods problem, since while everyone benefits from a greater response rate, there is an incentive to free ride on the contributions of others.

We compared awarding virtual points (conditional on completing the survey), varying the messaging to emphasize private or social benefits of participating, and displaying visual

[1] Porter (2004) provides a typology that we used to classify nanoHUB.org in this paper.
[2] *nanoHUB.org* has spun out its underlying technology into an open-source package titled HUBZERO, which in turn powers 40 other science and engineering HUBS to date.

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'observation cues.' Virtual points can be redeemed on the site for a limited number of rewards, and can therefore be interpreted as a quasi-monetary incentive to contribute.[3] Related work has found a positive effect of providing monetary rewards on an online question and answer site (Chen et al., 2007). Social benefit messaging, as compared to private benefit messaging, has been shown to be effective on increasing contributions of movie rating on the online website *MovieLens* (Rashid et al., 2006). *NanoHUB.org* is different from *MovieLens* in several ways – most notably, *nanoHUB.org* constitutes a scientific, rather than leisure, community. Finally, observation cues have been shown to increase monetary contributions to charity and in the laboratory, but have not been explored in an online setting (Haley and Fessler, 2005; Rigdon et al., 2009; Bateson et al., 2006; Krupka and Croson, 2009).

We find that survey participation and completion rates are significantly greater for the group receiving the virtual points. This result provides evidence for the power of quasi-monetary rewards in an online setting, adding to the large literature in economics on the impact of incentives. The slight change in messaging also has a significant effect. Participation, but not completion, is higher for the group exposed to the private benefit messaging as compared to the group exposed to the social benefit messaging. This finding is in line with standard economic theories that propose people are mostly self-interested. The observation cue does not have a significant effect.

[3] Specifically, filling out a survey (the action taken by participants in the experiment) results in being awarded 250 points. 2 items are available on the site, a gray t-shirt with the nanoHUB logo and a navy blue t-shirt with the nanoHUB logo. Each shirt costs 500 points, including shipping.

2. Experimental Environment

2.1 Experimental Setup

In 2012, *nanoHUB.org* had over 73,700 registered members. *Members* are students, university faculty and staff, government employees, or scientists in the private sector, who work predominately in the engineering or science fields. Over 13,000 of these registered users interacted with the site in the year 2012 alone. Registration is free, requiring only a name and valid e-mail address, and gives members access to contribute and use simulation tools, nanotechnology courses, tutorials, and seminars. Similar to other online communities, the content contribution pattern on *nanoHUB.org* follows the power law distribution in which a large subset of users contribute nothing, and a few members perform most of the work (Adamic, 2000; Adamic et al., 2003). *NanoHUB.org* is interested in encouraging greater contributions of low-effort content, namely increasing the number of users who rate and review content (for instance, less than 0.5% of the users of a simulation tool rate it).

2.2 Experimental Design

30,000 randomly selected community members with a *nanoHUB.org* account (thereafter called 'users') were randomized to receive one of six possible e-mail requests to complete a survey. Table 1 summarizes the treatment groups. The surveys varied in three different ways. First, we varied whether users were offered site-specific virtual points (called "nanos" on *nanoHUB.org*) for completing the survey. Nanos can be exchanged for a limited number of rewards on the site's "online store" and each individual in this treatment received 250 nanos for completing the survey (equivalent to exactly half of an 500 point t-shirt, the only product on the site store). Since the offer of nanos provides an extrinsic incentive to complete the survey, we

posit that users who are offered nanos will participate in and complete surveys at a greater rate relative to users who are not offered nanos.

Second, we varied the type of social message: the message either emphasized the private benefit gained by the participant or the social benefit gained by the community from filling out the survey. The private benefit message read: '[…] evaluate how nanoHUB can better serve you […] help to make our site an even better information resource for you.' The social benefit message read 'evaluate how nanoHUB can better serve its users […] help make our site an even better information resource for your fellow nanoHUB community members.' Standard economic theories assume that most people are self-interested, while related work in behavioral economics has suggested that people have heterogeneous social preferences, ranging from purely selfish to varying levels of altruism (Gintis et al., 2005). Emphasis of benefits to the community has had a positive effect on movie ratings (Rashid et al., 2006). In addition, providing social comparisons has been effective at increasing online community contributions (e.g., Chen et al., 2010).

Table 1: Treatment Groups

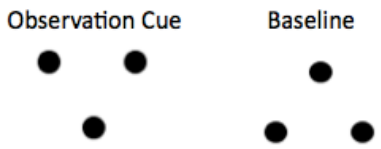
	Observation Cue	**No Observation Cue**
Private Benefit, 250 nanos	Not fielded	**(PB-250-nC)** N=5,000
Private Benefit, 0 nanos	**(PB-0-C)** N=5,000	**(PB-0-nC)** N=5,000
Social Benefit, 250 nanos	**(SB-250-C)** N=5,000	Not fielded
Social Benefit, 0 nanos	**(SB-0-C)** N=5,000	**(SB-0-nC)** N=5,000

Note: As shown, there were 6 different survey types. PB-250-nC and SB-250-C were not fielded due to sample size limitations.

Finally, we varied whether or not the user was exposed to the 'three dot' observation cue. Research in evolutionary biology has found that humans are sensitive to the act of being observed and react by increasing their level of cooperation within their peer group. In addition, biologists find that human beings are sensitive to a certain type of 'observation cue' stemming from a physiological adaptation for facial recognition. Exposure to 'eyespot cues,' or drawings of eyes or of dots representing eyes, activates the fusiform area of the brain, and may 'fool' the

individual to unconsciously believe that he or she is being observed (Tong et al., 2003; Johnson and Morton, 1991). Several recent papers in economic psychology have harnessed this information, using treatments consisting of exposing potential donors to 'eyespot cues' and have found that such cues indeed increase monetary donations to charities, in particular for 'in-group' donors (Haley and Fessler, 2005; Rigdon et al., 2009; Bateson et al., 2006; Krupka and Croson, 2009). As in related work, in the treatments with the cue, three dots in the eyes/mouth configuration were displayed using asterix (*) at the top of the email and in a small bitmap image at the top of the survey page – see Figure 1. In the treatments without the cue, the same three dots appeared upside down in both locations. We propose that observation cues could have a positive effect on participation on the survey, in line with the positive effects observed for monetary contributions.

Figure 1: Observation Cue



We followed the same protocol for all treatments. Each survey was sent out on two different dates (a Saturday and a Tuesday in late August), for a total of 12 separate batches of e-mail solicitations. The surveys were sent on behalf of the *nanoHUB.org* assessment team, and users were not aware that they were participating in an experiment. Users received an e-mail solicitation that included a link to the *nanoHUB.org* survey page, which repeated the same information to the e-mail prior to the start of the survey. In treatments where respondents were eligible to receive reward points, points were deposited in the user's account at the completion of

the survey.[4] This methodology followed the existing practices for collecting survey information on *nanoHUB.org*. Some participants had participated in (non-experimental) surveys in the past.

In treatments PB-0-nC and SB-0-C, which did not offer a nano reward in the e-mail, we also surprised a randomly selected half of participating users with a 250-nano reward for completion. This surprise reward was announced on the web-site prior to the start of the survey.

3. Results

Table 2 summarizes the participation rate, completion rate, and days to response for each treatment group (treatments ordered by response rate for ease of comparison). On average, we observe a 2.58% response rate, with response rates ranging from 1.96% in SB-0-C to 3.68% in PB-250-nC. Conditional on participating, we observed high completion rates – over 70% of surveys were completed on average across all treatments. Users took between 5 and 7 days to complete the survey.

Table 2: Response Rate, Completion and Days to Response*

	Participation Rate	Completion Rate	Days to Response
SB-0-C	1.96%	79.59%	6.96 (8.01)
SB-0-nC	2.12%	80.19%	6.69 (7.73)
PB-0-C	2.26%	73.45%	6.80 (7.11)
PB-0-nC	2.54%	76.38%	6.31 (6.74)
SB-250-C	2.92%	84.93%	5.83 (4.92)
PB-250-nC	3.68%	85.87%	7.15 (7.60)

Note: *Values in parentheses represent the standard errors. Completion rate is reported conditional on participating.*

We find support for the conjecture that offering virtual points increases response and completion rates relative to not offering points. Response rates in groups receiving the offer of points were 27-31% higher relative to response rates in groups not receiving points. Comparing

[4] Users were not required to log in to nanoHUB.org to participate in or complete the survey, but users in the treatment with rewards were required to log in to claim their nanos.

response rates of 3.68% in PB-250-nC with response rates of 2.54% in PB-0-nC, we find statistically significant differences (χ^2 test p-value < 0.01). Likewise, comparing response rates of 2.92% in SB-250-C with response rates of 2.12% in SB-0-nC, we find statistically significant differences (χ^2 test p-value = 0.01).

Because participants could decline to answer questions, our best proxy for completion was to count any survey in which the at least one of the four questions on the last page was filled out complete. Other definitions of completion (answering two out of four questions, etc.) yielded similar results. Completion is greater in the group receiving points, and this is significant for the private benefit treatments (χ^2 test p-value = 0.03 for PB-0-nC versus PB-250-nC and p-value = 0.28 for SB-0-C versus SB-250-C). Table 3 reports probit models of survey participation and completion that confirm the results from the Chi2 tests. The surprise reward (250 nanos for completion, announced to those who chose to participate) also improved completion rates, but the result is not significant. This brings us to the first result.

Result 1: Offering virtual points in the solicitation e-mail significantly increases online survey response and completion rates of registered *nanoHUB.org* users.

Table 3: Probit Model of Survey Participation and Completion

Dependent Variable:	**Participation (0/1)**	**Completion (0/1)**
Reward Point	0.17***	0.36***
(1 if yes, 0 if no)	(0.03)	(0.11)
Observation Cue	-0.04	-0.09
(1 if yes, 0 if no)	(0.03)	(0.11)
Social or Private Messaging	-0.07**	0.13
(1 if social, 0 private)	(0.03)	(0.11)
Surprise Reward		0.24
(1 if yes, 0 if no)		(0.16)
Observations	30,000	774

*Note: *** p<0.01, ** p<0.05. Standard errors in parentheses. Completion is defined as answering at least one of the four questions on the last page.*

The finding that providing virtual points, which is a quasi-monetary incentive, increased response and completion rates is intuitive and is predicted by our theory. This result is also in line with results from many related studies in economics, which find support for the value of monetary and quasi-monetary incentives (Jobber et al., 2002; Chen et al., 2007). However, it is a not a trivial result. For example, the alternative theory of motivation crowding suggests that applying a monetary incentive to an activity that is considered morally or socially good may actually *decrease* contributions (Frey et al., 2001).

Next, we explore the effect of messaging that emphasizes either private or social benefits. We find that private benefit messaging is more effective than social benefit messaging. Private benefit messaging increases participation rates by 13% - 17% relative to social benefit messaging. The probit regression reported in Table 3 shows differences that are significant at the 5% level (*coefficient* = -0.07, *p*-value < 0.05). However, individual tests comparing PB-0-C to SB-0-C and PB-0-nC to SB-0-nC do not show statistically significant effects (χ^2 test *p*-value = 0.16 for PB-0-C versus SB-0-C and *p*-value = 0.29 for PB-0-nC versus SB-0-nC). While we did not include direct comparisons of private versus social benefit messaging in the groups receiving virtual points, these results may imply that the private benefit messaging is most influential when combined with virtual points. Post-estimation tests conclude that incentives are significantly more effective than the social benefit messaging on participation rates. This brings us to the next result:

Result 2: Private benefit messaging is significantly more effective than social benefit messaging at motivating registered nanoHUB users to participate in the survey (in treatments with points).

Our finding of the effect of private benefit messaging suggests that online communities should be careful in designing solicitation messages, since even small changes in wording can affect participation behavior. In this case, our finding that private benefit messaging is more effective than social benefit messaging in this scientific community is the opposite of the result of Rashid et al. (2006), who studied a leisure community. Rashid et al. (2006) found that in the leisure community in which users rate movies, private benefit messaging was *less* effective than social benefit messaging. In Rashid's study on *MovieLens,* users were 4.8% *less* likely to rate a movie on when they were shown 'smilie emoticons' that indicated a value to self than when they were shown 'smilie emoticons' that indicated value to peers. This difference can be explained by the difference in context: on *MovieLens,* individuals visit for leisure and may feel more socially connected to their peers, while on nanoHUB*,* individuals visit for intrinsically competitive educational and research purposes and may be more self-oriented and less socially connected.

We also measured the impact of the observation cue, three dots, on participation and completion. We expected the observation cue to have a positive impact on participation and completion, in particular in treatments where social benefit was stressed. However, we do not find differences in the participation or completion rates with and without the observation cue in the direction we expect. Predicted response rates are in the opposite direction and the difference is not significant (PB-0-C response rate 2.26%, PB-0-nC response rate 2.54%, χ^2 p-value = 0.36, and SB-0-C response rate of 1.96% and SB-0-nC of 2.12%, χ^2 p-value = 0.57).

Related work argued for the positive benefit of observation cues (Haley and Fessler, 2005; Rigdon et al., 2009; Bateson et al., 2006; Krupka and Croson, 2009). However, we do not find significant differences in participation rates with and without the observation cue. Several differences between our design and the experiments conducted in previous work may shed light

on this discrepency. Krupka and Croson (2009) conducted a mail campaign soliciting donations for a local library, and found that the effect of the observation cue was driven primarily by donor type – only existing donor response rates were significantly affected by the eyespot treatment. Krupka and Croson (2009) posit that observation is effective among those individuals who are members of the group (i.e., previous donors), but not for those who are not.

Because this is a scientific, rather than leisure, community, one explanation could be that these users may have greater social distance from the community and may not be as responsive to observation cues. If the observation cue works primarily by increasing response rates of individuals who were already contributing, as in the library donations example, and (as evidenced by lack of response to social benefit messaging and few low-effort contributions on the site itself) many nanoHUB members are more self-oriented, the observation cue would not have an effect. This brings us to the last result:

Result 3: The observation cue does not have a significant effect on survey participation for registered nanoHUB users.

5. Discussion and Conclusion

To investigate the effects of different motivations to participate online, we conducted a field experiment in the world's largest virtual nanotechnology user facility, *nanoHUB.org*. 30,000 users were randomly selected into one of several treatment groups, and received e-mails soliciting their participation in an online survey. As expected, survey participation and completion rates are increased for groups receiving the virtual points. The slight variation in messaging also has a significant effect: participation rates are greater for users receiving the

private benefit messaging relative to the social benefit messaging. The observation cue does not have a significant effect.

Our results have important practical implications for designers of online communities. First, virtual points, which are generally less costly than monetary incentives to implement, almost double response rates. In addition, private benefit messaging in our context has a significant effect on participation rates relative to social benefit messaging. One possible reason is that on *nanoHUB.org*, users may participate primarily for self-interested reasons (because it is a science and engineering community, rather than a leisure community). However, designers of online communities should keep in mind the importance of message framing on the impact on low-effort contributions such as survey responses or rating of content. While the observation cue, which has an evolutionary biology backing, and is effective in many domains offline, we do not find support for its use in our context.

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Appendix: Survey Recruitment E-mail Examples

SB-250-C

Subject: nanoHub Survey! Help the community and earn 250 points!

* *
*
Dear nanoHUB user,

We have invited you to evaluate how nanoHUB can better serve its users. Your responses will help to make our site an even better information resource for your fellow nanoHUB community members.
Please complete a brief survey. The survey should take no more than 15 minutes to complete.
We'll give you 250 points for completing the survey!
Your responses are completely anonymous.
Click here to complete the survey:

- the nanoHUB team

SB-0-nC

Subject: nanoHub Survey! Help the community!

*
* *
Dear nanoHUB user,

We have invited you to evaluate how nanoHUB can better serve its users. Your responses will help to make our site an even better information resource for your fellow nanoHUB community members.
Please complete a brief survey. The survey should take no more than 15 minutes to complete.
Your responses are completely anonymous.
Click here to complete the survey:

- the nanoHUB team

PB-0-C

Subject: nanoHub Survey!

* *
*
Dear nanoHUB user,

We have invited you to evaluate how nanoHUB can better serve you. Your responses will help to make our site an even better information resource for you.
Please complete a brief survey. The survey should take no more than 15 minutes to complete.
Your responses are completely anonymous.
Click here to complete the survey:
- the nanoHUB team