A Comparison of Social, Learning, and Financial Strategies on Crowd Engagement and Output Quality

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ABSTRACT
A significant challenge for crowdsourcing has been increasing worker engagement and output quality. We explore the effects of social, learning, and financial strategies, and their combinations, on increasing worker retention across tasks and change in the quality of worker output. Through three experiments, we show that 1) using these strategies together increased workers' engagement and the quality of their work; 2) a social strategy was most effective for increasing engagement; 3) a learning strategy was most effective in improving quality. The findings of this paper provide strategies for harnessing the crowd to perform complex tasks, as well as insight into crowd workers' motivation.

Author Keywords
Crowds; incentives; strategies; motivations

ACM Classification Keywords
H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces – Collaborative computing, Computer-supported cooperative work, Web-based interaction

INTRODUCTION

A major research challenge in crowdsourcing has been increasing crowd worker engagement and output quality [4,8,16,19,20,21,26,33,37]. One significant issue has been that crowd platform features aimed at lowering market transaction costs – such as simplified work histories, de-identification of worker names, and lack of long-term contracts – can, on the one hand, enable employers to hire workers without the significant vetting and handshake costs prevalent in other markets, leading to high-speed, scalable transactions. On the other hand, they do not promote a particularly fulfilling or engaging environment for workers, who can feel like "just another cog in the machine" [12], with corresponding negative implications for motivation, effort, and output quality [4,17,20,34].

CSCW'14, February 15 - 19 2014, Baltimore, MD, USA.

http://dx.doi.org/10.1145/2531602.2531729

As a result, large crowd employers (such as CrowdFlower or MobileWorks) have begun to build up and train their own trusted workforces of crowd workers, and researchers have investigated "retainer" models to keep workers around [22]. However, such approaches may not work for many crowd employers, who do not have the volume of work to continuously feed a dedicated workforce. In this paper we compare combinations of three task design strategies – social, learning, and financial – to determine what kinds of features can be incorporated into marketplaces to create rewarding or fulfilling experiences for crowd workers, and thereby increase crowd worker engagement and output quality. Specifically, we examine the effects of these strategies on attracting workers to come back to take additional tasks from the employer (engagement) as well as changes in the quality of their work (output quality). Furthermore, we go beyond investigating individual strategies to look at interactions between strategies.

Job Design Strategies

In traditional organizations, a variety of strategies are designed to encourage employees' engagement and productivity. Theories on job design and motivation theory in conventional work organizations indicate that job design should focus on human needs and workers' motivations [24]. Job design researchers stress the importance of performance feedback, learning, and interaction with other people in determining the attitudes and behavior of employees in organizations [35]. Literature on human resource management suggests that individual performance appraisal (and the rewards associated with the appraisal), training, and team building are the main activities that motivate workers [3]. In brief, the strategies that are effective for improving engagement and output quality mainly include a social, learning or training, and financial component, and these strategies are very often implemented together.

While the effects of job design are well established in conventional work organizations, the features of crowdsourcing markets, including their reliance on one-off impersonal transactions, crowd workers' demographics, and lack of effective punishment mechanisms [20, 34], make it unclear how crowd workers will respond to these strategies. In traditional organizations, employees are situated in a hierarchical and long-term situation, and their behaviors are influenced by such an environment. For example, employees are motivated by a social strategy because maintaining a good rela-

tionship with coworkers is important to gain resources, mentorship, or promotion [e.g., 30,31]. In contrast, crowdsourcing markets have little concept of such resources, mentorship or hierarchy. Therefore crowd workers might not be interested in putting in the effort to maintain certain relationships, and a social strategy might not be effective. As for a learning strategy, most crowd workers treat the work in crowdsourcing markets as complementary to their main jobs [34]. Therefore, they may only want to earn quick money by working on simple tasks instead of learning skills. Lastly, micro- and low-pay tasks are prevalent in crowdsourcing markets, and the hourly-rate is a few dollars [34]. A financial strategy within the current payment range is unlikely to make big changes to crowd workers' income and thereby might not affect their behavior. To summarize, due to the fundamental differences between crowdsourcing markets and traditional organizations, it is not clear whether strategies that work in traditional organizations would be effective in improving crowd workers' engagement and performance.

We therefore try to apply such strategies and test their effects on crowd workers. The goal for this strategy design is two-fold: 1) increase a worker's predisposition to return to work for a particular employer without requiring a longer-term employment contract; 2) increase a worker's motivation and ability (expertise) to perform high quality work for that employer. Specifically we extend the piece rate pay model typical of crowdsourcing markets with a *financial strategy* based on long-term rewards contingent upon quality work. We augment these financial strategies with a novel *social strategy*, that involves building teams and allowing interaction between workers as well as between workers and employer, and a *learning strategy* that involves providing detailed performance feedback to workers. These three strategies aim to redesign crowd worker/employer interactions to support greater opportunities for relationships to develop between workers and employers (and potentially between workers as well). In addition to these individual strategies, we create different mechanisms by combining the strategies in order to find optimal ways of increasing both engagement and quality.

Our results suggest that the social strategy has positive effects on worker engagement and the learning strategy improves output quality, while the financial strategy has neither effect. Additionally, the social, learning, and financial strategies seem to undermine each other's positive effects when used together.

The contributions of this work are two-fold. First, this work provides empirical test to the effects of incentive strategies on crowd workers' engagement and performance. Second, our findings can be used to guide the design of crowdsourcing platforms, including incorporating interaction and training features.

RELATED WORK

Financial strategies have been studied to improve the quality of crowd work. However, researchers showed that while increasing payment attracts more workers faster, it does not consistently improve the quality of their work [26, 33, 37]. These studies applied simple financial incentives, such as paying more on single tasks. Among simple tasks with similar levels of difficulty, ones offering higher payment can stand out and attract more workers. Increasing complex tasks' payment might not produce the same effect, because these tasks compete for workers with simple tasks in the same market. It is difficult for workers to determine whether the extra effort required by the difficult tasks is worth the extra payment. Thus, we can't predict workers will behave in the same way as they did in performing simple tasks. In addition, there are many types of financial incentives, such as base salaries, bonus contingent on performance, long-term accumulated reward, and their combinations, which can be used to increase employees' commitment and performance [18]. Their effects on crowd workers remain to be tested.

Increasing the intrinsic motivation of a task has also been tried. In this view, researchers framed tasks in a meaningful context, such as labeling tumor cells in order to assist medical researchers, but found that while the framing motivated individuals to do more work, again work quality (i.e., accuracy) did not improve [4]. A later study appealed to altruism by contrasting work for a non-profit versus a profit-making corporation, and found that appeals to altruism increased the quality of work [33]. These studies were based on the assumption that if workers find the task more engaging, interesting, or worth doing in its own right, they may produce higher quality results. Unfortunately, most tasks don't seem engaging to workers and can't be framed as altruistic work.

Other techniques, such as providing instant feedback and establishing connection with workers' peers, have also been tried. For example, Dow and colleagues found that providing crowd workers with instant feedback increased the quality of work [8], and Salganik and colleagues showed that asking subjects to consider the answers of their peers increased accuracy on a content analysis task [37]. In addition, a recent study found that revealing demographic information of workers' teammates could motivate workers to put more effort into the task and thereby improve quality [16]. While valuable, these studies focused on simple tasks where low quality is not likely due to inherent difficulty of the task, but through worker carelessness or lack of effort. Although complex tasks can suffer from similar issues, they also suffer from workers' limited expertise. That is, even if workers are motivated enough to pay attention, they still can't improve their output quality because they lack the required skills.

STRATEGY DEVELOPMENT

Social Strategy

Social factors such as the desire to feel a sense of involvement and 'belong' to a social group, and the forming and maintaining of interpersonal bounds, are a fundamental hu-

man need [2, 14]. Traditional organizations have tried many ways of building up social relations between employees to facilitate collective actions [e.g., 25]. Empirical studies also show that social motivation is an important driver for people taking part in online activities, ranging from knowledge contribution to providing emotional support [e.g., 32, 40].

Crowdsourcing markets are centered on work and pay. There is limited direct social interaction in current crowdsourcing markets. Whether social motivation is important to crowd workers, and whether a social strategy can keep workers around, is unclear. Crowd workers might have self-selected into a system of financial reward, and therefore would not be interested in social motivation. Additionally, most crowd workers have their own formal jobs and working in crowdsourcing markets is just a way of earning quick money [34]. Thus they might think of social factors as unnecessary or even a burden. However, in slightly different online environments researchers who study the relation between socialization tactics and newcomers' commitment to peer-production projects found that social interaction increases participation [5]. Although crowdsourcing markets are different from peer production communities, they share two important features in common: participants are self-selected and this activity is not their main job. Researchers argue that people can become committed to a group or community through identity or bound-based commitment [29]. Self-disclosure plays a central role in the development and maintenance of relationships [6]. Therefore, we designed a social strategy to build bounds between workers, as well as between workers and employers. Specifically, we will invite workers to be part of a team, encourage them to introduce themselves, and allow workers to talk to each other. We predict,

H-S1: A social strategy will improve workers' engagement.

The effect of social factors on the quality of work is complex due to many possible dynamics. On one hand, high commitment resulting from social factors might increase work performance [27]. On the other hand, different social dynamics can affect work performance in different directions [e.g., 10]. For example, positive interaction with team members might benefit performance and conflicts might reduce performance.

In crowdsourcing markets, recent work has shown visual presentation of co-workers changed workers' perceptions of co-workers, and that the more co-workers participants saw, the lower their work quality [19]. But another recent study found that revealing demographic information of co-workers could increase social transparency, motivating workers to put more effort into the task when interacting with their teammates [16]. Although such studies and some practices tried indirect collaboration and coordination among crowd workers, there isn't yet any study focused on allowing workers to interact with each other socially in the way we propose in crowdsourcing markets. In our proposed social strategy, there will be awareness, interaction and self-disclosure. These social factors are intended not only to increase social transparency, but also build workers' trust and bond with their co-workers and the requester, which might improve the quality of their output. Therefore, we predict that,

H-S2: A social strategy will improve the quality of crowd work.

Learning Strategy

There are many studies in traditional organizations showing feedback can improve quality. Feedback can be provided by either superiors or peers. For example, on-going feedback from instructors can improve students' learning [41], employer feedback can foster employee development [23], and providing or receiving peer feedback for students reinforces their learning and enables them to achieve higher understanding [9].

Related work shows several ways of improving the quality of crowd work in crowdsourcing markets [e.g., 8, 19]. However, we argue that these motivators largely improve quality by reducing lazy or careless work. For example, Dow et al. showed that instant feedback improved crowd workers' output quality [8]. It is unclear whether the improved work resulted from learning or from a supervision effect: workers feeling monitored and therefore paying more attention. In addition, the task was writing a product review, and the finding may not apply to more difficult tasks. As argued before, crowd workers might not be willing to spend time on gaining knowledge or learning skills considering that most of them have formal jobs. Workers may also not trust the feedback provided either by their peers or the requester. However, workers might like to learn skills while making money. Feedback tailored to their previous performance can help them be aware of the issues they had, and they might try to correct these issues next time when they work on similar task. We designed a learning strategy by means of providing feedback asynchronously, on more difficult tasks, given either by experimenters or co-workers. We posit feedback can improve quality by improving workers' expertise. We predict,

H-L1: A learning strategy in the form of providing feedback will improve the quality of crowd work.

Although we created a learning strategy to improve quality, we are also interested in seeing how it influences engagement. Hackman and Lawler describe feedback as one of four task dimensions that are important in the generation of intrinsic rewards, and thereby increase employees' engagement [12]. However, in many situations, feedback's effect on engagement is mediated through motivations. Positive or negative feedback can provoke different motivations and therefore lead to different effects on engagement. For example, researchers found that positive feedback led to higher levels of intrinsic motivation [38], but studies in peer production show that providing negative feedback can reduce newcomers' general motivation [43].

The effect of feedback on engagement has not been studied in a crowdsourcing context. On one hand, workers might like to learn skills while making money and therefore be more likely to participate. On the other hand, learning might demotivate workers because feedback often involves negative assessments about the workers' output quality. Such assessments might discourage workers and therefore decrease their engagement rate [42]. Therefore, we predict,

H-L2: A learning strategy will not improve workers' engagement.

Financial Strategy

The effects of financial strategies on the quantity and quality of an employee's work have been controversial in traditional organizations (reviewed by [17]). As discussed previously, crowdsourcing markets have a new model of employer-employee relationship. The effect of financial incentives in such markets deserves investigation.

Previous studies used one-off short-term financial incentives. These studies showed an effect on quantity of crowd work but no effect on the quality of work [e.g., 26]. Researchers explain this finding as an "anchoring" effect: workers who are paid more also perceive the value of their work to be greater, and thus are no more motivated than workers paid less.

These studies focused on one-time fixed payments or a bonus. Many types of financial incentives in traditional organizations, such as base salaries, bonus contingent on performance, long-term accumulated reward, and their combinations are used to increase employees' commitment and performance [18]. There are few studies of systematic financial incentives in crowdsourcing markets. To design a long-term systematic financial strategy, we enhance the standard payment rate by paying an extra bonus to returning workers, provide performance-contingent incentives such as building credits in our system over time, and promise to solve disputes fairly. Workers were told they would receive such special financial treatment if they kept taking our tasks and individually or as a team performed well in a task. This financial strategy is designed for long-term and contingent on engagement and performance. Therefore, we predict,

H-F1: The financial strategy will improve workers' engagement.
H-F2: The financial strategy will improve the quality of crowd work.

Combining Strategies

This paper aims to explore optimal ways of increasing crowd workers' engagement and output quality for complex tasks. As discussed above, we are interested in the effects of both individual strategies and their combination. If these individual strategies produce positive effects, can we create an even more effective strategy by combining them?

There has been little research on the interactive effects of multiple strategies except on the interaction between extrinsic and intrinsic incentives. In the motivation literature, "crowding out" effects were found with external incentives such that students paid to play with a puzzle later played with it less, and reported less interest than those who were not paid to do so [7]. However, researchers also found that one can combine extrinsic and intrinsic motivators in a synergistic way and thereby gain a higher level of employee satisfaction and performance [1]. In addition, researchers in the crowdsourcing literature found a synergistic interaction between intrinsic and extrinsic motivators: workers provided highest quality results when intrinsic motivation was stronger than extrinsic motivation. Once extrinsic motivation took over, accuracy converged to equal (and lower) levels regardless of the level of extrinsic motivation provided [33]. These findings indicate the complexity of interaction among incentives. Many factors, including the phrasing of the treatments, and the way of integrating different types of strategies, could affect workers' behavior. Therefore, we take an exploratory approach to experiment with different ways of combining strategies in order to find an optimal way of designing strategies for crowd workers.

We conducted three experiments. In each we presented multiple tasks in different steps across several months to test the effects of strategies. The participants were all recruited from Amazon Mechanical Turk. To avoid sampling bias, we first recruited a pool of subjects to perform an initial task and then sent them messages to invite them to complete more tasks. Depending on the experimental conditions, different strategies were used in invitations–a social strategy, learning strategy, financial strategy, or interactive (combined) strategies.

We first conducted an omnibus experiment in which we compared the effects of an invitation with all three strategies to the control condition with only the notification of the new task, looking at workers' engagement and output quality. We then tested the individual strategies and the interactive strategies in two subsequent experiments. Workers were asked to summarize portions of scientific articles (for example, the first two paragraphs from an academic paper [15]). We selected this task because writing tasks are complex tasks that call for particular skills, effort, and potential collaboration.

EXPERIMENT 1: AN OMNIBUS WAY OF TESTING STRATEGIES

In Experiment 1, we aim to test the overall effect on engagement and quality from all strategies. To do so, we used a multiple-tasks procedure. We posted a first task recruiting a pool of workers and then divided them into two groups receiving different treatments. We then invited them back to take more tasks. Our experimental condition invited workers back with a combination of social, learning and financial strategies, and a control condition only notified workers about new tasks with simple messages.

Subjects

Overall 236 workers participated in the experiment. Thirty-

eight percent of participants were women, 69% were native English speakers, and 64% received college or higher education. Their average age was 32, and ranged from 18 to 75.

Design and Procedure

Step 1. We posted a summarization task requiring workers to summarize two paragraphs taken from a scientific article into a few sentences [15]. Workers self-selected to take the task.

Step 2. We posted a second summarization task (four paragraphs taken from [39]). We divided participants from Step 1 into two groups: a control group and a strategy group. The control group received a simple notification about the task, as shown below.

Looking for HITs? We are going to offer HITs on reading and writing. The goal of these HITs is the production of news articles. The tasks include reading articles, summarizing articles, writing sentences and judging writing.

The strategy group received an invitation about joining a news-article writing team with rewards (bonus and credits) as well as learning promises (learn the skills to be a journalist). The main part of the message is shown below.

We are building a news article writing team. The goal of the team is the production of news articles through a series of tasks. The tasks include reading articles, summarizing articles, writing sentences and judging writing.

We are seeking good and responsible workers as partners. We are only inviting participants who did well on the initial writing assignment. You took our previous task "News article writing!" We would like to invite you to be on our writing team.

The reasons you might be interested in doing this: 1) You will get an extra five cents bonus for every task you complete. 2) By working on our tasks, you will be building up your credits in our system. You will get a final reward depending on your credits: we will select the team member with the most credits every other month and reward him/her 10 dollars. 3) You will know about the task as soon as we post it. 4) You are going to learn the skills of a journalist. 5) You will belong to a news article writing team.

What we need from you is simple: please take all the tasks you accept seriously and do your best on every task. Please introduce yourself by replying to this invitation (e.g. What do you do for a living? What is your expertise? What kind of tasks do you like to do on Mechanical Turk? Why are you working on Mechanical Turk?)

Workers in the strategy team then sent their self-introductions to employers. Below is an example of the self-introduction from one worker:

*Let me start by saying how very glad I am that you invited me to your writing team. I am currently in the process of studying law at the **University. Writing articles and/or reviews for numerous sites, including Mechanical Turk, is my source of extra income and a way to fill my free time. I mostly write and summarize news articles, movie and music reviews, and basically all kinds of articles on general topics, or the ones I'm particularly interested in. I would also be interested in editing/judging others' writing. Concerning my personal information, I have no problem sharing it with other workers, but please inform me if your intentions were to create some kind of work groups.*

Step 3. We posted a third summarization task (two paragraphs from [36]), and sent different messages to the two groups notifying them of this task. The control group received a simple notification message about the task. The strategy group received messages that confirmed workers' membership in the news-article writing team and the bonus and credits they received from doing the previous task.

Step 4. At the end of Task 3, the strategy group received bonus and credits.

Rating

A good summary needs to cover the key ideas in the original text accurately but concisely. Two judges rated the summaries on 7-point Likert scales of *coverage*, *accuracy* and *conciseness*. We averaged these assessments using the geometric mean to normalize differences among the variance in the judgments [11]. The geometric mean of three assessments is the cube root of their product. The inter-rater agreement scores on the quality measures for the summaries were adequate: Intraclass Correlation Coefficient (ICC) was .76. The final analysis was based on the averaged scores of the two judges.

Analysis and Results

Engagement was measured by return rate, which is the proportion of the participants who returned in the final task, given they received a message in the first task. The quality of the summaries was calculated as the geometric mean of accuracy, conciseness and coverage. Thus, the dependent variables were return rate and quality. The independent variables were conditions: the control condition and the strategy condition. We included two control variables in the analyses: education and language. Education was a binary variable, measured by whether the participants received college or higher education. Language was also a binary variable, measured by whether the participant's native language is English or not. Both the variables were coded as 1 and 0 using dummy coding. They were selected as control variables because workers with higher education and higher English skills might be more likely to come back, which may result in sample bias.

The first goal was to examine how strategies resulted in changes in return rate. We constructed a logistic regression model with return rate as the dependent variable, conditions as independent variables, and education and language as control variables.

The second goal was to examine the changes in the quality of the summaries. To do so, we used a multiple regression analysis with quality as a dependent variable, and conditions as independent variables. Only a subset of participants had been invited to perform Task 2 and Task 3. (This is because we wished to observe changes in behavior of participants who received the complete treatment. Since some participants dropped out at each step, we focused on the subset of

Conditions	Probability of Return	SE	Mean of Quality	SE
Control group	.24(27/117)	.04	4.87	1.27
Strategy group	.36(40/119)*	.04	5.74*	1.28

p < .001 = ***, p < .01 = **, p < .05 = *

Note: The first numbers in the parentheses were the numbers of participants in the final task and the second numbers were the numbers of participants in the first task.

Table 1. Experiment 1: Effects of strategies on return rate and quality

participants who stayed throughout the process.) The characteristics of the workers, such as their education level and native language, can influence both whether they would stay through the tasks and their quality, so it was necessary to control the selection biases when modeling changes in quality. To do so, we used the Heckman two-step selection model [13], which performs multiple regressions to generate a derived variable predicting whether a participant would complete a new summary. This propensity score was then used as a control variable in the second stage of the analysis predicting changes in quality. When modeling the worker's propensity to persist, we included in the first stage of the Heckman analysis the education and the language variables.

Table 1 summarizes the results: compared to being in the control condition, being in the strategy condition increased the return rate by .12 (p<.05), and the quality by .87 on average (p<.05), holding all other variables constant. These results suggest that an invitation with all strategies motivated crowd workers to return, and the workers produced better work when they returned.

Discussion

The strategy condition included social, learning and financial elements. As a whole, these strategies improved workers' engagement and their output quality. However, it was unclear which strategy led to the effects, and we couldn't determine interaction effects between strategies. In addition, in this instance the learning strategy was a promise of learning about news article writing, but this was not operationalized. To improve Experiment 1 and test the effects of every individual and pairs of strategies, we designed Experiment 2.

EXPERIMENT 2: INVITATION WITH SINGLE AND INTERACTIVE STRATEGIES

Similar to Experiment 1, we used a summarization task to recruit workers and then divide them into groups receiving different treatments for the following tasks. Different from Experiment 1, we are interested in the effect of individual strategies and their interaction. Thus we break the overall invitation with all strategies into three separate conditions: *Social*, *Learning,* and *Financial* conditions. We also created three conditions with interactive strategies: *Social & Learning, Social & Financial,* and *Learning & Financial.*

Subjects

Overall 1,171 workers participated in the experiment. Forty-four percent of participants were women, 73% were native English speakers, and 63% received college or higher education. Their average age was 30, and ranged from 18 to 74.

Design and Procedure

Step 1. We posted a summarization task and workers self-selected to take the task (same as used in Experiment 1).

Step 2. We posted a second summarization task (same as Experiment 1). We divided participants who completed Task 1 into seven groups and then sent them invitations with different messages.

Control group. Workers received a notification about the new task that was similar to the one used in Experiment 1.

Social group. Workers received an invitation to join a news article writing team. Part of the message is shown below.

We are building a team of dedicated workers to produce news articles. The tasks will include reading articles, summarizing articles, writing content, proofing, copy-editing, and judging others' writing. We are seeking good and responsible workers as members of this team. We would like to invite you to be part of the team.

To build a strong team, we would like to get to know you better and encourage team members to know each other. Please introduce yourself by filling out the following information.

What do you do for a living? What is your expertise? What kind of tasks do you like to do on Mechanical Turk? Why are you working on Mechanical Turk? Would you like to share your information with other team members?

Learning group. Workers received an invitation with promises of providing knowledge about scientific discoveries and providing feedback on their summaries. Part of the message is shown below.

You will learn about cutting-edge scientific discoveries when you take our tasks. The topics of the tasks range from social science to natural science. Articles you are writing about are from top researchers around the world. We will also provide you feedback on your tasks, including the quality of your writing and ways of improving it. You will also learn some skills that are important for writing news articles professionally.

Financial group. Workers received an invitation with promises of providing extrinsic strategies such as paying bonuses, giving credits and solving disputes appropriately. Part of the message is shown below.

By taking our tasks, you will enjoy the following benefits:

1) You will get an extra five cents bonus for every task you complete.

2) By working on our tasks, you will be building up your credits in our system. You will get a final reward depending on your credits: we will select the team member with the most credits every other month and reward him/her 10 dollars.

3) You will know about a task as soon as we post it, notified by e-mail.

4) We will pay you promptly and if any problems arise will contact you for dispute resolution rather than rejecting your work.

There were three interactive strategy groups: *Social &*

Learning group, Social & Financial group and *Learning & Financial group*. The messages these groups received were pairs of the messages shown above and the appearance orderings of the messages were randomized.

Step 3. We posted a third task (same as the one used in Experiment 1), and only participants who took Task 2 were allowed to take the new task. Before taking Task 3, groups received different messages.

The control group received a simple notification saying that a new task was available.

Groups involving the social strategy (*Social group, Social & Learning group* and *Social & Financial group*) sent their self-introductions to employers and received confirmations of their group membership.

Groups involving the learning strategy (*Learning group, Social & Learning group* and *Learning & Financial group*), received feedback tailored to their summaries for Task 2. Below is an example of feedback from the experimenters,

You did a good job in summarizing the DARPA text! Our main suggestion for you is to try to cover all important information in the text and leave out the unimportant information. Here are a few places that can be improved: 1. About MIT's incentive strategy: the amount of money for people involved is detailed information which can be removed from the summary. 2. An important piece of information was missing in your summarization: GTRI team's financial strategy was to donate all money to charity.

Groups involving the financial strategy (*Financial group, Learning & Financial group* and *Social & Financial group*) received bonuses and credits.

Step 4. At the end of Task 3, groups with the financial strategy received bonus and credits, and groups with the learning strategy received feedback.

Rating

We rated the summaries in a similar process as in Experiment 1. Due to the large number of summaries, only a sample of summaries (50 summaries) were selected and rated by two judges. The inter-rater agreement score on the overall quality was good (ICC=.81). One judge rated the remainder of summaries.

Analysis and Results

The analysis was similar to Experiment 1, the main difference being the independent variables. We were interested in the effects of every single strategy and the interactive strategies. So rather than using conditions as independent variables, we used strategies as independent variables: conditions were coded into three dummy variables: social, learning and financial. If a variable existed in a condition, it was coded as 1. Otherwise it was coded as 0.

We conducted a logistic regression model with return rate as dependent variable, strategies and the interaction between strategies as independent variables, education and language as control variables.

	Probability of Return	SE	Mean of Quality	SE
Control	.13 (22/176)	.27	3.81	.61
Social	.21 (35/169) *	.30	4.69 *	.62
Learning	.12 (19/160)	.33	4.76 *	.63
Financial	.15 (25/165)	.32	4.62 *	.63
Social&Learning	.13 (23/172)	.45	4.35	.65
Social&Financial	.20 (34/167)	.42	4.35	.61
Learning&Financial	.09 (14/163)	.49	3.98	.72

$p < .001$ = ***, $p < .01$ = **, $p < .05$ = *

Table 2. Experiment 2: Effects of strategies on return rate and quality

Regarding quality, we conducted a Heckman two-step selection model with quality as dependent variable, strategies and the interaction between strategies as independent variables, and education and language included in the first stage.

The results are shown in Table 2. The second and the third column show the return rates and standard errors. The logistic regression analysis shows that compared to receiving the control invitation, receiving an invitation with just the social strategy increased the odds of participants' return by .61 ($p<.05$), holding all other variables constant. The rest of the strategies, including the single strategy and the interactive strategies, didn't predict return rate.

The fourth and fifth column of the table show the means and standard errors of quality for the final task. Heckman regression analysis shows that the presence of one unit of social, learning or financial strategy increased the quality by .89 ($p<.01$), .95 ($p<.05$), and .82 ($p<.05$) on average, holding all other variables constant. This means all single strategies improved the quality.

We observed a negative interaction between every pair of strategies. Examining the improvement in quality as compared to control, the social strategy improved quality by .89 (3.81 to 4.69), the learning strategy by .95 (3.81 to 4.76), and the financial strategy by .82 (3.81 to 4.62). Therefore, one might expect that combining social and learning strategies should lead to a 1.84 increase in quality, but we saw a .55 (3.81 to 4.35) increase. Similarly, combining social and financial should lead to 1.70, but we again saw a .55 (3.81 to 4.35) increase. Combining learning and financial should lead to 1.77, but we saw a .17 (3.81 to 3.98) increase. This means adding strategies together did not produce additive effects. Particularly, adding the learning strategy to the financial strategy even reduced each positive effect.

Discussion

Experiment 2 results show that a social strategy improved both workers' engagement and output quality. These results support H-S1 and H-S2. As we discussed in the previous section, this manipulation might increase a worker's sense of belonging and build bonds between workers, as well as between workers and experimenters. Therefore the workers were more likely to return and do better. However, in Ex-

periment 2, there was no direct interaction between team members of social groups.

As predicted by H-L1 and H-L2, the learning strategy only improved the workers' output quality. This suggests that workers could learn skills by reading feedback. However, negative feedback such as "you missed one of key ideas in the original article" might discourage them to return.

The financial strategy improved quality, not the return rate, which supports H-F2 but not H-F1. This finding contradicts findings in previous studies that financial rewards led to higher engagement but had no effect on quality. It might be because participants were told that they were only invited back when they did well in the tasks, so unlike prior work the reward was contingent on quality. This demotivated workers who did not want to work hard to come back.

Another finding was the negative interaction between strategies: when we added a second strategy to the existing one, it either did not provide an additional effect, or even reduced the existing positive effect of the single strategy on quality and return rate. This negative interaction was especially strong for the interaction between learning and financial strategies: the mean quality was as low as that of the control condition. This finding can be explained by the "crowding out" effect in previous literature [7]. Without theoretical support for the negative interaction between other strategies (social and learning, and social and financial), we have two conjectures. First, the negative interaction might be caused by the design of the conditions: we simply put together the two independent messages. Without appropriate integration of the strategies, workers might be confused by the large amount of information and therefore only paid attention to one of the strategies. Second, there might be a ceiling effect: given that summarization tasks are not easy, there is only a limited amount of space for workers to improve and the improvement resulting from the single strategy already reached the limit. We conducted Experiment 3 to better understand the interaction between strategies.

EXPERIMENT 3: IMPROVED INTERACTIVE STRATEGIES

To improve interactive strategies, we created mechanisms to better integrate the strategies rather than just put strategies together. For example, in Experiment 2 the social and learning message was simply the individual messages concatenated. In Experiment 3, we ask team members to provide feedback for each other, so the social element and the learning element are dependent on each other.

In addition to improving the interactive strategies, Experiment 3 is also designed to improve several other aspects of Experiment 2. We found a positive effect on engagement and quality from the social strategy. But there was only an imaginary team and no real interaction between team members in Experiment 2. To strengthen the effect of the social strategy, we here add interaction between team members by allowing them to chat to each other. Moreover, Experiment 2 did not test the interaction between all three strategies. This is added in Experiment 3. Lastly, messages with treatments were sent to the participants in emails in Experiment 2, and we were not sure whether these messages were read by participants. To ensure that participants are actually exposed to the treatments, in Experiment 3 we ask participants to read the treatment messages by taking tasks like surveys.

Subjects

Overall 2,018 workers participated in the experiment. Forty-three percent of participants were women, 80% were native English speakers, and 50% received college or higher education. Their average age was 32, and ranged from 18 to 70.

Design and Procedure

Step 1. We posted Task 1 and workers self-selected to take the task (the article was the same used in the previous experiments).

Step 2. We divided workers from Task 1 into eight groups and sent them messages inviting them to take a survey containing different treatments.

The treatments in control, social, learning, and financial groups were similar to the ones used in Experiment 2. The main changes were in the interactive strategy groups.

Social & Learning group. Participants were invited to join a team. They would provide and read feedback for and from their team members. This design intended to create a group-learning environment. Part of the message is shown below.

…The team members will evaluate each other's answers and provide feedback, including the quality of the writing and ways of improving it…

Social & Financial group. Participants were invited to join a team. As a team they would compete with other teams and would receive rewards based on their performance. This design intended to create a group competitive environment. Part of the message is shown below.

…Your team will compete with another team. If your team wins, all your members will enjoy the following benefits:

1) You will get an extra five cents bonus. 2) By working on our tasks, you will be building up your credits in our system. You will get a final reward depending on your credits: we will select the team member with the most credits every other month and reward this team member 10 dollars. 3) You will know about a task as soon as we post it, notified by e-mail. 4) We will pay you promptly and if any problems arise we will contact you to resolve the problem instead of rejecting your work…

Learning & Financial group. Participants were informed that they would receive feedback and they would receive a reward if they improved. This design intended to motivate the participants to learn by using rewarded learning. Part of the message is shown below.

…We hope you will learn the skills of writing news articles by taking our tasks. We will provide you feedback on your quality, including the quality of your writing and the way of improving it. If your skills improve, which is measured by the number of errors you make, you will enjoy the following benefits…

Social & Learning & Financial group. Workers were invited to join a team. They would provide and read feedback for and from their team members. In addition, as a team if they win, they would get a reward. This design intended to encourage teams to improve together. Part of the message is shown below.

… As a member of the team, you will be asked to evaluate each other's summaries. That is, you will provide feedback on one of your team members' summary and will also read the feedback on your summary given by your team members. We hope as a team you can help with each other and do your best. In the meantime, your team will compete with another team. If you win, all members will enjoy the following benefits…

Step 3. Groups with social and learning strategies (*Social & Learning* and *Social & Learning & Financial group*) were asked to read and give feedback on their team members' summaries. They were told that their team members took the same tasks and they were asked to evaluate their summaries for coverage, accuracy and conciseness. They also needed to provide feedback including the merits and the flaws of the summaries. At the same time, experimenters produced feedback for the non-social learning group (*Learning group* and *Learning/Financial group*). After all the feedback was generated, groups with the learning strategy (*Learning group, Social & Learning group, Learning & Financial group* and *Social & Learning & Financial*) received feedback.

The financial group received rewards. Groups with a social strategy (*Social group, Social & Financial group, Social & Learning group* and *Social & Learning & Financial group*) sent us their self-introductions and then received welcome messages with a short introduction to their team members.

Step 4. We posted Task 2 and sent different messages to groups (two different articles were used in the task: [36] and [39]. Participants were presented with one of them randomly). For groups with social strategies, there were chat boxes (we customized chat boxes from cbox.ws) embedded in the task interface to increase the interaction between team members. For the *Financial group*, there was a reminder of reward at the top of task. For the groups with learning strategies, feedback was reminded at the top of the task.

Step 5. After Task 2, participants in the groups involving financial reward received rewards. Participants in the groups involving learning received feedback.

Rating

Different from the previous experiments, we used crowd workers (who were independent of the experiment) to evaluate the summaries. Each summary was rated by three workers on its accuracy, conciseness and coverage on 7-point scales. To control the quality of the rating, verification questions were embedded in the task: two questions were about the content of the original text and the raters were also asked to provide feedback for the summaries. After the rating was finished, experimenters examined the ratings and removed the ratings from turkers who did not pass the verification questions. Only the ratings from the judges who gave reasonable answers to the verification questions and summary feedback were used. The ratings were averaged across raters: each summary received average scores on its accuracy, conciseness and coverage. These scores were converted into a final quality score by using the geometric mean. To check the reliability of the crowd's ratings, one experimenter rated a sample of 34 summaries independently. The inter-rater agreement on the sample was adequate (ICC=.63).

	Probability of Return	SE	Mean of Quality	SE
Control	.06 (18/290)	.33	4.82	.70
Social	.13 (31/244) *	.31	5.20	.67
Learning	.05 (13/281)	.38	5.81 **	.73
Financial	.10 (24/243)	.33	5.27	.67
Social&Learning	.10 (22/218)	.48	5.28	.73
Social&Financial	.10 (24/245)	.44	5.07	.72
Learning&Financial	.09 (24/259)	.48	5.11	.70
Social&Learning& Financial	.13 (32/238)	.64	5.28	.67

$p < .001$ = ***, $p < .01$ = **, $p < .05$ = *

Table 3. Experiment 3: Effects of strategies on return rate and quality

Analysis and Results

The analysis for Experiment 3 was similar to the analysis in Experiment 2. The results are shown in Table 3. The second and third column show return rates and standard errors. Logistic regression analysis showed that one unit presence of social strategy increased the odds of participants' return by .78 (p<.01). The rest of the single strategies and interactive strategies did not predict the return rate.

The fourth and fifth column show the means and standard errors of quality. We can see that one unit presence of learning strategy increased the quality by 1.00 (p<.01) on average. The other two individual strategies did not predict the quality.

We also observe a negative interaction between two pairs of strategies. The learning strategy alone increased quality by 0.99 (4.82 to 5.81). Therefore, one would expect that combining social and learning strategy should lead to at least a 0.99 increase, but instead we observed a .46 (4.82 to 5.28) increase. Similarly, combining financial with learning, we saw a .29 (4.82 to 5.11) increase. This means adding either a social or financial strategy reduced the learning strategy's positive effect. However, when we added both social and financial strategies to the learning strategy, this negative interaction was mitigated: given that both strategies reduced learning strategy's effect, we would expect an even lower quality in three-strategy condition. However, we found that every presence of social & learning & financial strategy increased the quality by .46 (4.82 to 5.28) (p<.05).

Discussion

Experiment 3 produced some consistent and inconsistent results with that of Experiment 2. First, the learning strategy's effect was consistent: a positive effect on quality but not return rate. This result suggests that it is possible to create a process allowing workers to provide feedback for each other and improve their skills.

Second, the social strategy continued to have a positive effect on return rate but not on quality. In Experiment 3, we added chatboxes to increase the interaction between workers, (in Experiment 2, there was no direct interaction between participants), which might distract them from focusing on the tasks. This may indicate that social interaction between workers should be controlled at the appropriate level, and designed in a task-centered way. We examined the content of the chatting between team members. Some were task-related and some were not. We did not keep track of an individual's chat messages, so we are unable to undertake further analysis to confirm our conjecture.

Third, the financial strategy no longer had an effect on either quality or return rate. As we can see from the design of the new interactive strategies, participants need to learn or compete with each other or other teams to receive reward. This might demotivate them. In addition, in some conditions, the reward was not delivered until the end of the final task. Participants might not be motivated until they received a reward.

Fourth, even after we designed new ways of integrating the strategies, the paired interactive strategies still had a negative effect on quality: both social and financial strategies reduced the learning strategy's positive effects. Even adding a third strategy reduced such negative interaction, the average quality for *Social & Learning & Financial* (M=5.28) was still lower than that of using the learning strategy alone (M=5.81). This means the negative interaction among strategies might not be caused by the method of integrating them, but something else. We further discuss this issue in the discussion section.

SUMMARY AND DISCUSSION

In this paper, we explored strategies to increase crowd workers' engagement and performance. We used social, learning, and financial strategies, as well as their combinations. We conducted three experiments to test the effects of every single strategy and the interaction of strategies.

The Social Strategy

Social strategies were shown to be most effective in improving crowd engagement. In our study, even though we either only promised a team, or added simple chatboxes, we still found powerful positive effects on workers' engagement across tasks. This finding is interesting for two reasons. First, considering that complex tasks benefit from a sustained workforce and might require collaboration between workers, this finding suggests that using social job design mechanisms may be effective for building teams of workers who could work together across multiple tasks. Second, a social strategy might improve crowd workers' wellbeing by satisfying their social motivation rather than treating them as independent workers. Regarding the social strategy's effect on *quality*, it had a positive effect when there was only an imaginary team and self-disclosure of workers' information, and the effect disappeared when real interaction between workers was provided. This indicates that task irrelevant interaction might distract workers from focusing on the tasks. However, this needs to be further tested in the future.

The Learning Strategy

A learning strategy was shown to be most effective in improving quality. This finding is consistent with previous research from Dow et al. [8]. However, we provide new insights: 1) Workers are able to provide feedback to each other's work and learn through feedback on complex tasks. 2) Unlike the previous study where feedback was presented synchronously, our feedback was provided asynchronously and workers made progress in a different new task. This shows the promise of training crowd workers over time, and building a skilled workforce for complex tasks.

The Combined Strategy

The social and learning strategies seem to make an ideal strategy to incentivize workers: using a social strategy to attract workers and a learning strategy to improve their skills. One might assume combining multiple strategies can improve both engagement and quality. However, when we tried to combine strategies, we found that the effects were not additive on either engagement or task quality. Indeed, some combinations, especially the learning and financial combinations even undercut the positive effect from the single strategy. Except for the negative interaction between the financial and learning strategy, we are not aware of theories to explain such complex interaction among the other strategies.

As discussed in the beginning of the paper, interaction among different factors could be complex, especially considering that in online experiments it is not clear which part of the treatments the participants were exposed to and focused on. The integrated mechanisms might change the initial intention of each single strategy and induce a different mindset in crowd workers and lead to worse results. That the effects of social and learning strategies were not additive might be because workers who concentrated on learning either did not care about social interactions, or were distracted by them. For example, in Experiment 2, workers not only need to read feedback but also introduce themselves, which might result in higher cognitive load and therefore a lower level of performance. Regarding the interaction between social and financial strategies, the financial strategy involves competition between workers (being rewarded if accumulating most credits among all workers) and this relation might undercut the bonding effect we tried to build with the social strategy.

However, the interaction between the three strategies in Experiment 1 and Experiment 3 resulted in a more positive effect. This may be because even though in Experiment 1 we combined all the strategies, each one of them was not fully operationalized and therefore didn't lead to strong conflicts. In Experiment 3, the three-strategy-interaction was constructed differently with a common goal: group members help each other to compete with another group. This design conveyed a clear and non-conflicting goal.

Therefore, we conjecture that when using multiple strategies, they should be designed in a way that signals a clear and coherent goal and involves minimum cognitive load for workers. However, these conjectures need further investigation and evidence. It is also likely that there is a ceiling effect on participants' behavior: even if participants are motivated by multiple strategies, there is only a limited space to improve for both return rate and quality.

Limitations

This work is limited in several ways. Even though we tried to operationalize the three strategies, such as adding chat boxes to allow interaction, asking workers to provide feedback to each other, and providing rewards, these strategies still functioned more as recruitment strategies than systematic strategies, because they were only implemented for three tasks. For example, we didn't successfully build real teams to compete with each other or work together synchronously. Regarding the learning strategy, we didn't differentiate between learning about general science versus learning job skills. It may be interesting in future work to test these types of learning apart. For example, crowd workers who are intrinsically motivated might like to learn about general science, while those who are extrinsically motivated might be more interested in learning job skills. Learning strategies could be tailored to these differences.

In addition, we only tested the strategies in Amazon Mechanical Turk. We varied the base payment from 40 cents to 150 cents in the three experiments, and the bonus included 5 cents and 10 dollars (conditional to the credits they accumulated), with consistent findings across experiments. Because these payments roughly cover the price range of many micro-task (and even some macro-task) crowdsourcing markets, we think the findings, especially findings about the learning and social strategies, may be generalizable among crowdsourcing markets such as Amazon Mechanical Turk, CrowdFlower, MobileWorks, and others. Other crowd communities such as Wikipedia involve many different motivations other than pay, including reputation, altruism, and fun [28]. Therefore, while our financial strategy findings are likely less relevant, some of our findings on social and learning strategies might apply to such communities.

Through experiments involving thousands of workers, we found that the final return rate was about 15%. This low final return rate was partially caused by the experiment itself. We needed to focus on participants who accepted the complete treatments. Participants who were not able to take a task within the given time slot were excluded in the following tasks. Ignoring that constraint, after the first task 50% participants were willing to come back. This suggests the opportunity and possibility of building stable long-term strategies with ad-hoc collections of crowd workers.

CONCLUSION

This paper attempts to improve our understanding of applying job design mechanisms – including social, learning, and financial strategies – to increasing engagement and output quality in crowdsourcing markets. Through three experiments we showed that a social strategy is most effective in building the crowd's loyalty, and a learning strategy is most effective in improving their skills. The complex findings about interactions between strategies suggest that multiple strategies should be carefully designed. Strategies applied in parallel can cancel out each other's positive effects.

This work provides ways of increasing crowd engagement and output quality. Techniques we described provide opportunities for improving the interaction between employers and workers, and the interactions between workers themselves, as well as training and learning possibilities. In this way, mechanisms can be built to improve crowdsourcing markets that will enable better crowds and more complex and high quality crowd work.

ACKNOWLEDGEMENT

This work was supported by NSF grants IIS-1149797, IIS-1217559, OCI-0943148, IIS-0968484, IIS-1111124, Bosch, Google, and Microsoft, and Carnegie Mellon's Center for the Future of Work.

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