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Article

The effect of financial and food-based incentives on math test performance

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SUMMARY

Previous research has suggested that incentives may be effective in increasing a student's math performance. The purpose of this study was to extend previous research and give monetary and food incentives in the same period. Twenty-nine students with Algebra 2 experience took incentivized math tests with two different types of incentives: monetary and food. The financial incentive outperformed the control, but the food incentive did not. We also considered the relationship between the students' math grades and the effectiveness of each incentive by correlating their math grades to the difference in scores between the control and incentive conditions. The relationship between participants' math scores and the incentive effect for food was positive and significant, but not significant for the effectiveness of the financial incentive. Therefore, teachers should consider using math incentives such as money to increase their students' math test performance. We suggest more research is needed on the precise effectiveness of food as an incentive.

INTRODUCTION

Incentives are usually used to help people perform well during a task, and research suggests performance can be increased if used correctly (1). Incentives, including prizes or rewards, are common in workplace environments, while incentives are not as common in academic settings (2). Incentives can vary in context, from a raise in salary in a business to a small toy for a child. However, high school students are often only incentivized by their grades (3). What if cash or food could also incentivize performance and further increase grades for high school students? Many variables can alter the effectiveness of incentives, such as the type of incentive, amount of incentive, gender of the recipient, and the task incentivized (1,4, 6). If incentives improve performance, it is important to determine how teachers can use them effectively to increase classroom achievement. In our study, we gave students a math test under three different conditions – a control, a financial incentive, and a food-based incentive – to see which one helps students the most.

Incentives can be used in many forms as well as multiple types. A study by Levitt et al. determined that different types of incentives will affect performance differently (1). The researchers presented students with a standardized test and different types of incentives. The normal incentive was $20, $10, or a trophy. Normal incentives were provided if they met the requirements for receiving them. Loss incentives were also used, where the students were initially given them and then told that if they did not meet the requirement for their test, they would have to give the incentive back (1). The loss incentive resulted in worse performance than no incentive and the normal incentive outperformed both. Out of all the subjects, the incentives had the largest effect on math. It was also found that financial incentives proved to be more effective for males and older students while it was less effective for younger students (1). However, other studies have not found a similar effect for gender on incentives (4). This is important to our study because it gives insight into which incentives are more likely to yield negative and positive results. In the high school context, money given in a class like math might produce the biggest effect.

Other research, in contrast, has found that incentives do not always increase performance in schools (2). This may be due to a lack of knowledge, lack of interest, problems outside of the task, and a lack of correlation between the task and how it's measured (2). For example, the students may be driven to perform the task for the incentive but don't know how to achieve it. Other students find themselves wanting the incentive, but not wanting to put in the work for it (2). It can also be the incentive does not correlate with the task at hand. An example of this is in a study where students had to score an 80% on a test as their final task but were getting an incentive for reading books (2). The authors suggest reading books alone does not increase one's reading test abilities (2). These variables contribute to the reason incentives aren't always as effective in school settings and care must be taken to match the incentive to the task.

Incentives come in different forms like financial, awards, and even academic bonuses, but one of the less commonly accepted is food. Food as an incentive in schools is frowned upon for multiple reasons because it is often viewed as "unhealthy" even though food as an incentive may bring about positive results in behavior and academics in the short term (5). The Connecticut State Department of Education argues that food as an incentive in the classroom compromises classroom learning, contributes to poor health, and encourages "overconsumption of unhealthy foods, poor eating habits, and increases preference for sweets" (5). Therefore, in this study, we tested the effect of food on performance, to determine if its benefits might outweigh the drawbacks.

Overall, research has suggested that incentives affect performance, and have the possibility of producing positive results. This study contributes to our understanding of incentives because, to our knowledge, no one has done an academic study on both food and monetary incentives. This study provides a direct comparison between these two types of incentives and determines which one is better in an academic setting.

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For our study, a group of students was given three separate math tests over a period of time. First, we hypothesized that scores on a test would differ significantly by incentive type: money, food, or none. This is because research suggests that the amount the incentive is valued will affect performance (3). Second, we hypothesized that there is a positive relationship between math ability, as measured by a student's grade in class, and how much the incentives increase one's performance. This is because research shows that math is the subject most affected by incentives in general, and performance is dependent on the level of one's ability to score higher and a person's interest in completing the task (2, 6). Overall, we found that financial incentives had a positive significant effect compared to no incentive, but no effect for food incentives. However, math grades were positively related to the increase in food incentive performance, suggesting additional research on the potential for food incentives should be considered.

RESULTS

We expected to find that incentives have a positive effect on performance. To test the effect of incentives on performance, we constructed three different math tests, with two different incentive types and a control for a group of 11th and 12th grade student volunteers, all with similar math backgrounds. The three math tests comprised SAT questions of similar difficulty, with the three conditions being no incentive, a $2 reward, and a snack. The 29 students were assigned one of the three tests randomly to take on each day, with each day being a different incentive. All students took all three tests and participated in all three experimental conditions. Then students were scored; if they got 5 or more correct out of 10 they received an incentive.

Our first hypothesis was that test scores will differ by incentive. Test scores are based on three different practice SAT tests, each with 10 questions. Three incentives were used: no incentive, food, and money. We found a significant effect of incentive type on student performance using a one-way ANOVA for correlated samples ($F(2,56)=3.47$, p-value=0.038). We used a Tukey post hoc test analysis to determine the money incentive (M=5.4 SD=2.3) outperformed the control (M=4.25 SD=2.2, p-value <0.05). All other differences, including the food incentive (M=5.0 SD=2.1, p>0.05), were not significant **(Figure 1**).

Our second hypothesis was there is a positive relationship between math ability and incentive effectiveness. We used students' semester one math grades to measure their math ability. To measure the effect of food and money incentives, we subtracted the two incentives' results from the results of the control group and found a positive, non-significant relationship between the effect of money and math ability as measured by math grades ($r(27)=0.29$, p=0.07) (**Figure 2**). However, we did find a positive significant relationship between the effect of food and math ability ($r(27)=0.45$, p-value=.007), suggesting that students who score better in math respond better to food incentives than students who do not score as well (**Figure 3**).

DISCUSSION

In this study, we determined if incentives improved students' performance in mathematics. Our first hypothesis was that performance would differ by incentive type. This was partially supported because the money incentive group on average scored significantly higher than the no incentive group, but there was no significant difference between the food incentive and the no incentive groups (**Figure 1**). Our second hypothesis was that there was a positive relationship between incentive effectiveness and prior math performance. This was partially supported because the food incentive was correlated with students' math performance, but not the money incentive (**Figures 2 and 3**).

Our results are consistent with other studies by Levitt et al, and Gneezy (1, 4). Levitt found that financial incentives helped males and older students perform better on standardized math and reading tests (1). Gneezy found high financial rewards were linked to better performance (3). Our study found that financial incentives resulted in higher performance than the control. These studies help strengthen the claim that money helps people perform better. Additionally, the amount of money must be taken into account. Research on incentive amounts supports the claim that a sufficient amount of money must be given to yield positive results, while insufficient money incentives can worsen results (3). The environment and recipients of the incentives must be taken into consideration because the amount required will be different for every group. Our results suggest that $2 was sufficient. We chose $2 because it has immediate use for our participants. They could use the $2 to purchase something from the school store, giving the money immediate value.

There is little research on food as an incentive; however, we agree with other researchers that food incentives should be avoided (5). The first problem is incentivizing unhealthy habits. Giving food as an incentive is the same as telling someone it's okay to eat unhealthy foods for doing well. This could lead to poor health, especially if used in schools because they'll be forming these habits so young (5). Not only

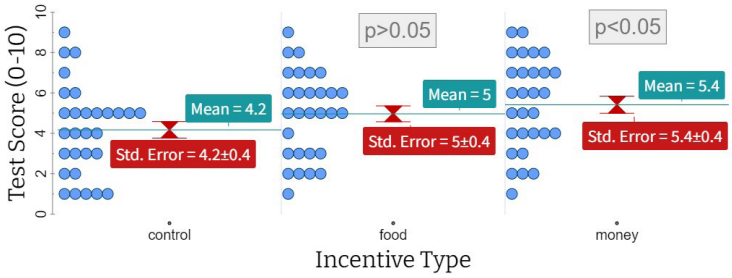

Figure 1. Test scores by incentive type. Test scores for students (n=29) receiving either no incentive or a food or money incentive over three days. The money incentive outperformed the control incentive (p-value <0.05, ANOVA test, with Tukey post-hoc analysis).

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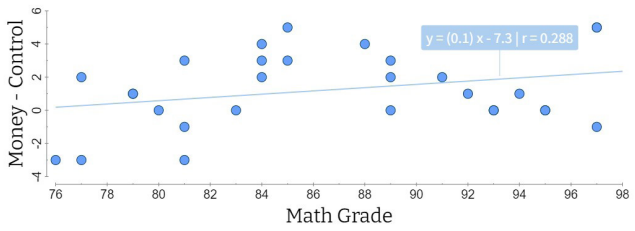

Figure 2. Effect of money on students' grades. Test scores for students (n=29) receiving no incentive, were subtracted from their score when receiving a financial incentive and correlated with their math grades. The relationship between the variables was not significant (p-value=0.07, Pearson correlation coefficient test).

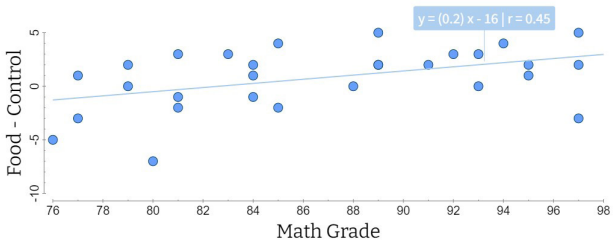

Figure 3. Food effect on semester 1 grades. Test scores for students (n=29) receiving no incentive, were subtracted from their score when receiving a food incentive and correlated with their math grades. The relationship between the variables was significant (p=0.007, Pearson correlation coefficient test).

is it an unhealthy habit, but its effectiveness is variable as an incentive. In contrast, money's effectiveness comes from the idea that participants can spend it however they wish. Instead of buying food as an incentive and promoting unhealthy habits, giving someone the money to buy whatever they want is better than deciding for them.

Similar to Levitt et al, we found that math is a potentially beneficial subject to incentivize in schools (1). The reason for this could be because of the objectivity of math; there is only one right answer. The incentives push students to work a little harder, and they put in a little more work to get the right answer. This is unlike a reading test, where no matter how much the answer is desired if the reading can't be understood, no answer will be found. Also, the value placed on the student's relationship with math must be taken into account (4). For our study, we used students who have previously taken Algebra 2 or are currently taking Algebra 2, with mostly honors classes to make sure they knew the concepts tested. Therefore, these students are similar to those in other studies where students had high interest and knowledge of their subject (4). Notably, we found that students with lower math ability did about the same as the control, while students with a higher math ability were more affected by incentives.

Our study had multiple limitations. Our first limitation was the number of people; it was hard to prove the effectiveness of food because we didn't have a large number of participants (29 students). Our suggestion for other researchers would be to include more people. Another limitation was our participants; they all came from different age groups. Some took Algebra 2 years ago and some were taking it at the time of the study. Our suggestion would be to find students of the same level and experience with math.

Another future improvement could be using healthy food options like fruits and vegetables, as well as not continuously giving food as an incentive to avoid the potential negative effects of food incentives on unhealthy habits. This may boost the effectiveness of food as an incentive. Also, finding if there is an emotional difference between receiving and missing the incentives could help researchers better understand the possible negative outcomes of incentives and whether they outweigh the positive benefits. Finally, it's important to consider the possible effect of the order of incentives in a pairwise study like this. We did not test incentive order as a variable, and it is unclear whether the order affected test scores. Future researchers may want to explore this further.
According to our research, incentives, especially monetary incentives, are likely effective in boosting academic performance on math tests. However, the amount and type of incentives used may cause the effect to vary. Therefore, incentives might be able to be implemented in academic settings to increase the overall performance of students. Teachers and administrators should focus on finding the right kind of incentive that works in their environment because this will vary from classroom to classroom.

MATERIALS AND METHODS

A total of 29 students at The Neighborhood Academy participated in the study. The students were between the ages of 15 and 17, and the group was 69% male and 31% female. Although the genders of our participants were skewed male, we don't expect this to have affected our results, as previous studies have shown that incentives do not differ in efficacy between genders (4). The students were selected based on their experience in math: Honors Algebra 2 (semester 1 average =86%), Standard Algebra 2 (semester 1 average =89%), and Honors Trigonometry (semester 1 average =87%) classes were used for this study as they had finished or were currently taking Algebra 2.

The incentives used were food (chocolate bars or assorted Flamin' Hot chips) and money ($2). Based on our personal knowledge of the students, we knew Flamin' Hot chips were the favorite, in addition to candy. The financial incentive was approximately equal in value to the food incentive, based on convenience store prices. For our tests, practice SAT tests were reviewed, and questions were selected that Algebra 2 students would be able to do (6). Using these questions, three 10-question tests were generated and taken by 6 volunteer students (not in the study) to make sure the test wasn't too easy or too difficult. The average scores of these tests were 5.5, 5.58, and 5.83 out of 10, so a cut-off of 5+, or "average, or better than average", was used for the incentive. The tests were also reviewed by a math teacher to make sure they were appropriate for Algebra 2 and were of similar difficulty. The participants were assigned random orders of the tests, but the groups of students were exposed to the incentive conditions in the same order.

Students participated in all three conditions; they took all three tests and were offered both incentives. The tests were randomized, so one incentive group setting had students taking different tests. Incentives were distributed in the group setting in the following order: food, control, then money. Evidence suggests that money would have a large effect, so it was saved for last (1). We didn't want to start with no incentive,

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because the participants may not care for future tests if they were not compensated right away. When distributing the tests, it was explained to each math class that they would have 10 minutes to complete the tests, and if they got 5 or more questions correct, they received the incentive for that day. The tests were graded and incentives were handed out during the same period. Tests were given every other weekday. All participants who were present for two or more of the tests completed them and were included in the study. Students absent for one test made it up on a later day.

Differences in performance using a one-way ANOVA test for correlated samples. Individual differences were found using a Tukey post-hoc test. Correlations were calculated using a Pearson correlation coefficient. The abbreviation M is the mean, and SD is the standard deviation. All tests were calculated using vassarstats.net with a 0.05 significant threshold.

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