Equal Opportunity Tactic: Balancing Winning Probabilities in a Competitive Classroom Game

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Abstract: The outcome of competition is heavily ability dependent—the more-able students always win while the less-able lose. However, individual abilities are different. Students who consistently demonstrate lower performance than their peers may feel discouraged and frustrated. These lower-performance students hardly have the same winning probabilities as more-able students. In this study the authors design equal opportunity tactic to moderate the difference in performance between more-able and less-able students. The tactic is incorporated into a competitive learning game, AnswerMatching, by assigning every student an opponent with similar ability. A preliminary experiment was also conducted to investigate the effects of the tactic. Results showed that the tactic could balance the performance as well as the belief about how well students could achieve. That is, less-able students could have similar winning probabilities to more-able students.

Keywords: Equal opportunity, competitive games, performance, winning probabilities

Introduction

Competition, despite its potential drawbacks, is an easily adopted and frequently used motivator in classrooms. However, the more-able students always win in a competition, while the less-able lose. Unfortunately and inevitably, in the years of schooling, individual abilities are different. Students care and constantly predict whether they will be winners or losers in the competition process, finally confirming or doubting themselves by the outcome. In schools, as well as in our real world, the less-able students, discouraged and frustrated, may have a lot of experience of being losers, not to mention having the same opportunity for owning the sense of achievement as the more-able students. Can we change this mercilessness? Perhaps we can, in a special instance in a competitive classroom game.

Many researchers have shown that competition may undermine the performance of those who have low self-efficacy when they lose (Bandura & Locke, 2003; Kohn, 1992). However, competition is also a frequently used activity in classrooms as well as in schools because competition, besides drawing attention and excitement, is a well-structured activity with clearly defined goal for participants. If the negative effects describe above could be eliminated, competition could be a motivator for excelling self.

When participating in a competition, students are exposed to a big deal of social comparison messages, which may influence their self-conception, emotions, and actions.
The sources of such messages come from not only teachers but also peers’ performance (Levine, 1983). Even in a learning environment where ranking of ability and grade are explicitly minimized, the behavior of comparing performance still occurs (Crockenberg & Bryant, 1978; Hechinger & Hechinger, 1974). In most learning activities including competition, people believe that performance is a direct outcome of ability. In fact, performance describes a relative relation between ability and task difficulty. Furthermore, if the task is relatively easy for a student, the performance will be higher than if the task is difficult or challenging. Because the learning task in a classroom is usually the same to all students, their performance explicitly indicates how able or unable they are. As a result, less-able students realize their actual ability with the hint of their performance. The objective of this research is to design a computerized mechanism, equal opportunity tactic (EOT), for balancing the opportunity of success between more-able and less-able students.

1. System Design

1.1 AnswerMatching: an Example of Competitive Learning Environment

This study applies EOT in a competition game, AnswerMatching (Chiang, 2006; Wu et al., 2007), as an example to demonstrate the design of EOT in a competitive environment.

The game is designed for practicing calculation after the procedure is taught. Figure 1 shows the interface of AnswerMatching. The game requires students to select the correct answers to ten questions as quickly as possible. In this paper, each question is a composite number; the corresponding answers are in the form of the multiplication of two numbers.

After being shown a question, the students could calculate the answer, if needed, and then select the answer card from sixteen decks in a shared space. Each deck is comprised of cards having the same answer, but each card has different scores. Students are paired to compete with each other. If a student selects the first card in the correct deck within 30 seconds, he/she receives 4 points; otherwise, he/she receives 2 points. However, if the student selects the wrong answer for a question, the score for that student is reduced by 1 penalty point. In other words, in a round with thirty correct answers, if the student selects all the correct answer cards first, they receive 120 points, and the student who selects all the correct answer cards second received 60 points. The system displays their final scores and ranking at the end of every round; the student with the highest score is the winner of the round.

1.2 Ability and Winning Probability

This study defines the ability as a triplet of accuracy, efficiency, and trial number. While accuracy is the percentage of correct answers, efficiency is the average number of correct answers in a given time and trial number was the number of answers which were found. With the definitions, the system can calculate the winning probability for every student by using formula (1). This formula is one’s expected value of scores, indicating one’s winning probability. In this formula, \( a \), \( e \) and \( n \) denote one’s previous ability stored in the databases—accuracy, efficiency and the number of trials respectively; \( e_o \) denotes the efficiency of the opponent. According to the game rules, if the student gets a correct
answer, he/she has an approximate probability of \( a \times \left( \frac{e}{e+e_o} \right) \) to take the first card and hence get 4 points, and a probability of \( a \times \left( \frac{e_o}{e+e_o} \right) \) to get 2 points; he/she also has a probability of \((1-a)\) of losing 1 point for the wrong answers.

\[
E_{\text{Score}}(a, e, n) = \left\{ \begin{array}{l}
a \left[ 4 \left( \frac{e}{e+e_o} \right) + 2 \left( \frac{e_o}{e+e_o} \right) \right] - (1-a) \right\} \times n
\end{array}\right.
\]

(1)

### 1.3 EOT in AnswerMatching

The generalized procedure for EOT is an iterative process consisting of three main steps—ability estimation, task manipulation, and performance update.

**Step 1: ability estimation.** EOT first estimates the ability for every student by the estimation formula described above. Because the value is empty at the very beginning, the system initialized all values of students as zero, treating them as the same. After the first round, the system should have enough data for estimating abilities.

**Step 2: task manipulation.** In the second step, EOT adjusts the task so that the difficulty can meet the estimated abilities. In other words, after ability estimation, EOT starts from the most-able student and pairs students who are the most alike in the actual performance. That is, every student has to compete against another student with similar ability. Under the tactic, less-able and more-able students may have almost equal opportunity of winning the game. If the student number is odd, the tactic let the least-able student answer questions without any opponent.

**Step 3: performance update.** In the third step, EOT records the student’s most recent performance and uses this data to update the values about their abilities in the databases. The purpose of this step is to obtain a dynamic and precise estimation of the students’ abilities.

### 2. Method

The first purpose of the preliminary evaluation was to examine the effectiveness of EOT. It was expected that EOT would balance the game scores between more-able and less-able students, compared with the strategy to match randomly. The second purpose was to investigate the effects of EOT on students’ beliefs on game scores. It was expected that, compared with the random strategy, EOT would also balance the performance-related beliefs between more-able and less-able students.

#### 2.1 Subjects

The subjects were two third-year classes \((N_1=24, \text{ and } N_2=30)\). Prior to carrying out the experiment, the researchers paid an advance visit to the two classes. Three rounds of AnswerMatching were conducted for collecting the basic multiplication ability of the students. At the time, although students had been informed that they would compete against opponents, they actually played the game individually.

The collected actual performance was used in two ways: to examine the homogeneity of the two classes and to estimate every student’s ability as described in the first step of EOT. Independent sample t tests showed that there were no differences in their accuracy \((t_{52})=1.680, SE=0.034, p>0.05\), efficiency \((t_{52})=1.077, SE=2.397, p>0.05\), and trial number \((t_{52})=1.077, SE=2.397, p>0.05\). The two classes were then assigned as EOT and RAN (random) groups. In the group of EOT \((N=24)\), students with similar ability were paired. In RAN group \((N=30)\), which served as a comparison group, students were paired randomly.
2.2 Measures

In this study, the dependent variables were performance and belief on performance. All measures were automatically collected by the system. Performance was measured by game scores directly. Belief on performance was measured by one’s prediction of perceived performance. That is, after each round of the game, students were asked to predict their game scores by a questionnaire item “how many points do you expect to get in next round”. The measure actually represented expectancy for success (Meece, Wigfield, & Eccles, 1990; Wigfield & Eccles, 2000), the belief about how well one would do on upcoming tasks. Higher predictions implied higher expectancy for success and a more positive affective status.

2.3 Procedure

One week after the advance test, AnswerMatching was conducted again in the same classrooms. After a warm-up round, all students played six rounds within two sessions (80 minutes). In each round, students were required to answer ten questions. The questions were the same in all rounds, but the questions and the answer choices were presented in different sequences. Before the activity, all students were asked to review the rules. They were also told that they would be competing against an opponent. However, the identity of their opponent would not be disclosed, so as to prevent possible preconceptions about their opponents. During the experiment, one researcher led the activity; four researchers made observation and took field notes. All researchers are trained to help students if they encountered technical problems. After every round, the students were prompted to predict their scores in the following round.

3. Results

3.1 Effectiveness of EOT

Figure 2 illustrates the overall scores in RAN and EOT groups. The two-way ANCOVA indicated that there was a significant interaction between group and ability ($F_{(1, 46)}=4.535$, $MSE=108.528$, $p<.05$). It should also be noted that the main effect of group was not significant ($F_{(1, 46)}<1$, $MSE=108.528$, $p>.05$), showing that EOT did not significantly change the mean of overall scores compared to the RAN group.

Two independent sample t tests were then carried out for the two groups. For RAN group, the simple main effect of ability was both significant (RAN: $t_{(28)}=3.502$, $SE=3.82$, $p<.05$). For EOT group, the simple main effect of ability on score was not significant ($t_{(22)}<1$, $SE=4.86$, $p>.05$). The result showed that EOT balanced the game scores between the more-able and the less-able students in a classroom without changing its mean because in EOT all students regardless of ability had opportunities to get the similar scores.

![Figure 2. Game Scores.](image)

![Figure 3. Prediction of Game Scores.](image)
3.2 Effect of EOT on beliefs

Figure 3 illustrates the prediction of game scores in RAN and EOT groups. The two-way ANCOVA indicated that there was a significant interaction between group and ability ($F_{(1, 46)}=12.230$, $MSE=180.356$, $p<.05$). Two independent sample t tests were then carried out for the two groups. For RAN group, the simple main effect of ability was both significant (RAN: $t_{(28)}=2.933$, $SE=5.61$, $p<.05$). For EOT group, the simple main effect of ability on score was not significant ($t_{(22)}<1$, $SE=6.86$, $p>.05$). The result showed that EOT could also balance students’ prediction of scores. In other words, in EOT condition, the less-able students could have similar beliefs in the outcome of competition to the more-able students.

4. Conclusion

This study utilized the EOT, an approach to moderating differences in performance, by manipulating the learning tasks for individual students. According to the result of the experiment, students in RAN group, appeared to perceive the score differences during the competition. The more-able students often talked about their scores excitedly and loudly, while the less-able students were worried that they could not catch up. The results implied that in an environment with unequal opportunity of performing well, the less-able students have lower confidence in themselves than the more-able students. In EOT group, the performance of students was not influenced by their abilities any more. Owing to the effect, all students could anticipate receiving similar scores regardless of ability. Such advantage of EOT provided students with information for developing confidence.

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