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Strategic Decision-Making in Student Duos: A Game Theory Investigation of Procrastination and Task Completion

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ABSTRACT:
This study examines how students choose to work or postpone the task assigned when working as pairs or teams. Using game theory tools, including payoff matrices, dominant strategies, Nash equilibrium and mixed strategy equilibrium, we explored the possible strategies different types of students use. For the investigation, we considered two types of students: hardworking and unmotivated. We also explored the possible factors that influence the utility gained from the task. Based on these, we built two types of games with different combinations of players. The key findings were able to demonstrate that unmotivated student pairs default to procrastination (incomplete tasks), hardworking pairs achieve prompt completion, and mixed duos create free-riding dynamics that demotivate diligent students, with extended models revealing impacts on efficiency and workload distribution, providing a theoretical foundation for optimising student collaboration.

INTRODUCTION

Procrastination or postponing is the voluntary delay of an action or a course of action. Despite delay being a worse-off action, it is observed to be prevalent among students and is particularly problematic when working in pairs or teams. Individual procrastination has been studied intensively. However, less attention has been paid to procrastination and other strategic interactions that occur between students when they are working as teams. With the increasing focus on teamwork skills and collaboration, understanding these dynamics is crucial for developing better educational workplaces.

Game theory works as a suitable framework for analysing the type of decisions students take as rational agents. In the context of student teams, the model can consist of two students as players, with two strategies: to procrastinate or to complete the task at hand. Utility can be derived based on four factors: the grade received from the work, leisure time, efficiency of work and fairness of distribution of work. Classic game theory tools, including payoff matrices, Nash equilibria, and mixed strategy equilibria, are employed to predict the possible outcomes of the interactions between the students.

Previous research has explored various types of games to predict how individual incentives can lead to suboptimal outcomes, such as the Prisoner's Dilemma and the Battle of Sexes. In academic contexts as well, similar results can be observed; unmotivated students tend to free-ride on hardworking students, while hardworking students are often demotivated to work when paired with unmotivated students or when their teammates procrastinate.

This study aims to model and analyse the economic and behavioural explanations for procrastination in student duos using game theory. Specifically, we seek to answer: What prompts a person to procrastinate as an individual or as a team? We hope to shed light on mechanisms that drive task completion and procrastination in teamwork.

Literature review:

A game is a competitive activity in which players contend with each other according to a set of rules[1]. The player is the party involved. When participating in the game, the players take up different strategies as they proceed through the game. A strategy is a complete plan of action that a player will use in a given circumstance in the game. The strategies the players will employ are based on what is best for the players. The strategies that the players employ are usually the ones that give the player maximum utility, or maximum satisfaction or happiness, given the circumstances. The utility function is represented by U(). For example, a student is given the option of buying a football that she likes or purchasing some shoes for school. As the student likes football, using it will give her more happiness and hence more utility, and she will choose to purchase the football. To represent the choices and outcomes in a game, payoff matrices are used. Payoff matrices are grid-like representations of the payout a player receives from arriving at a particular outcome.[2]. Games can be classified based on many factors. One of them is the number of players, which includes one-player games and 2 player games. A classic example of a one-player game is Person vs. Nature, the dilemma: Should I carry the umbrella or not? There is only one player in this game: the person who carries the umbrella.

		Nature	
		Rains	Doesn't rain
Person	Carries Umbrella	(10)	(0)
	Doesn't carry an umbrella	(-10)	(5)

Table 1: Person vs Nature[3]

An example of a two-player game is the Battle of Sexes, where a couple is deciding upon the movies they wish to see. There are two players involved here: the wife and the husband.

		Husband	
		Shawshank Redemption	The Godfather
Wife	Shawshank redemption	(3,2)	(0,0)
	The Godfather	(0,0)	(2,3)

Table 2: Battle of Sexes[4]

The wife wishes to watch and gets more utility from watching The Shawshank Redemption, while the husband prefers to watch The Godfather. However, both of them wish to watch the movie together and want to avoid watching separate movies. Hence, when they are watching the movie together, the player watching his / her favourite movie will get a utility of 3, while the player who is not watching their

[1] Osborne, Martin J. and University of Toronto. *An Introduction to Game Theory*. 2000.

[2] Hayes, Adam. "Game Theory: A Comprehensive Guide." *Investopedia*, 27 June 2024, www.investopedia.com/terms/g/gametheory.asp.

[3] Davis, et al. "Game Theory | Definition, Facts, and Examples." *Encyclopedia Britannica*, 13 June 2025, www.britannica.com/science/game-theory.

[4] Wikipedia contributors. "Battle of the Sexes (Game Theory)." *Wikipedia*, 21 Mar. 2025, en.wikipedia.org/wiki/Battle_of_the_sexes_(game_theory).

favourite movie will get a utility of 2 because they are watching together. However, when they are watching separately, even if they are watching their favourite movie, they don't get any utility.
The next factor is the availability of information with the player. There are games of perfect information, where each player knows all the events that have occurred before the move, the possible outcome for each move, all possible moves, the opponent's strategies and their own strategies at all times. For example, in the Prisoner's Dilemma, there are two prisoners caught (A & B), and they are being interrogated in separate rooms. If both of them admit to committing the crime, they will get 6 years ' imprisonment each. If one of them confesses and the other doesn't, the 'honest one' is released, while the silent prisoner is awarded a jail term of 10 years. If both of the prisoners stay quiet, they get 1 year of prison punishment each. In this game, both players are aware of the moves they have and the outcomes of their actions. Both prisoners will be making the move simultaneously.

		Player B	
		Confesses	Remains quite
Player A	Confesses	(2,2)	(10,0)
	Remains quite	(0,10)	(6,6)

Table 3: Prisoners' Dilemma [5]

In contrast to that, there are games of imperfect or asymmetric information, where the players do not have all the information with them. The third defining factor is the sequence of moves, or the timing of the players' make. Players can make the moves simultaneously or at a time. Players can make moves alternatively, for example, Player A makes a move of A1, followed by B1 of Player B, and then move A2 by Player A, and so on. Otherwise, players can also make moves in sets. For example, Player A makes moves {A1, A2, and A3}, while Player B can make moves {B1, B2, B3 and B4}, and it goes on. An action profile is the
list of all the players' actions. For example, in Prisoners' Dilemma, the possible action profiles are (Confess, Confess), (Confess, Remain Quiet), (Remain Quiet, Confess), (Remain Quiet, remain quiet). *Nash equilibrium* can be defined as an action profile $a*$ with the property that no player i can do better by choosing an action different from $a*i$, given that every other player j adheres to $a*j$[1]. Nash equilibrium can be described as a form of steady state. Let us assume that there are two players, i and j, and one action profile is a^*, where a^* is (a^*i, a^*j). This action profile is considered a Nash Equilibrium if, assuming j*'s* moves remain constant, player i has no reason to change their move, i.e., player i gets maximum possible utility from action a^*i.
In the example of Person vs Nature, there will not be any Nah equilibrium because there should be two players for a Nash Equilibrium to occur.
In the example of Battle of Sexes, there are two Nash Equilibria: (Shawshank Redemption, Shawshank Redemption) and (The Godfather, The Godfather). If either of the players change their strategy and go for different movies, their utility will drop to zero. Hence neither of them will change strategies.
In the game of Prisoner's Dilemma, the Nash Equilibrium is (Confess, Confess). Even though the best outcome for both of them is to remain quiet, if one of them deviates from the strategy and confesses, their

[5] Brams, et al. "Game Theory | Definition, Facts, and Examples." *Encyclopedia Britannica*, 13 June 2025, www.britannica.com/science/game-theory/The-prisoners-dilemma.

utility will rise to 10 from 6. This gives both the players incentive to deviate from being quiet. Hence, their Nash Equilibrium will end up being to confess.

METHODOLOGY

This study utilizes a theoretical approach to model strategic decisions taken by student duos. This includes constructing and analysing two-player games, with two types of players: Hardworking and unmotivated. The core objective is to determine how different combinations of student types influence the likelihood of procrastination or task completion and to identify the corresponding Nash equilibria and dominant strategies.

There are two types of players:

Hardworking students: They prioritize academic achievement and hence derive maximum utility from task completion and receiving good grades.

Unmotivated students: They prioritize leisure and derive maximum utility from the same. Even if given tasks, they don't put in maximum effort and produce comparatively lower-quality work

For each model, three types of games are constructed with three different combinations of students.

There are two models: Model 1 examines the simplest cases with fixed utility values and only two factors and Model 2 examines an extensive version with more influencing factors.

For each game, the dominant strategies and Nash equilibria are identified and analysed. In the absence of dominant strategies, mixed strategy equilibria were calculated and analysed.

The theoretical outcomes were compared to commonly observed behaviours in academic settings to validate the models' relevance and to illustrate how game-theoretic reasoning can explain procrastination and free-rider phenomena in student teams.

TWO PLAYER GAMES:

There are two types of players in these games: Hardworking students and Unmotivated Students.

Hardworking students are those who place studies as their priority and always derive maximum utility from getting good grades and completing tasks on time.

Unmotivated students are those who do not like studying or doing any work, and gain their utility from leisure or any other alternative to studying.

Model 1:

The team consists of two players. The maximum utility the players can derive is fixed and constant in each game and can be derived from either good grades or from leisure time from procrastinating the work. It can be given by

Equation: $\text{Utility}_i = \alpha\, \text{grade}_i + (1 - \alpha)\text{leisure}_i$

Where $\alpha \in [0,1]$

Game 1:

Both the players are unmotivated students. Hence, U(grade) = 0, and U(leisure) = 1 for both the players.

		Player B	
		Procrastinate	Does the work
Player A	Procrastinate	(1,1)	(1,0)
	Does the work	(0,1)	(0,0)

Table 4: Model 1 – Game 1

When Player A procrastinates, the best response for Player B is to procrastinate. When Player A procrastinates, the best response for Player B is to procrastinate. Hence, the dominant strategy for Player B is to procrastinate. When Player B procrastinates, the best response for Player A is to procrastinate. When Player B does the work, the best response for player A is to procrastinate. As the best response for Player A is to procrastinate regardless of Player B's responses, procrastination is the dominant strategy for Player A. As the dominant strategy for both players is to procrastinate, the Nash equilibrium is to (Procrastinate, Procrastinate).
This Nash equilibrium can be reflected in real-life observations as well, where we can observe that when two unmotivated students are teamed, they often procrastinate or do not complete the task at all.

Game 2:
Two hardworking students are teamed together. Both of them prioritize grades, and hence U(grades) = 1, and U(leisure) = 0

		Player B	
		Procrastinate	Does the work
Player A	Procrastinate	(0,0)	(0,1)
	Does the work	(1,0)	(1,1)

Table 5: Model – 1 Game - 2

The dominant strategy for both the players here is to do the work, and hence the Nash equilibrium is (does the work, does the work)
Again, this Nash Equilibrium is reflected in real-life observations, where we can observe that when two hardworking students are teamed, the task is completed promptly.

Game 3:
A hardworking student (Player A) and an unmotivated student (Player B) are teamed together. U(grade) = 1 for Player A, while U(grade) = 0 for Player B. Here, the dominant strategy for the hardworking student is to do the work, while the unmotivated student will procrastinate. The Nash equilibrium will be to (Do the work,Procrastinate).

		Player B	
		Procrastinate	Does the work
Player A	Procrastinate	(0,1)	(0,0)
	Does the work	(1,1)	(1,0)

Table 6: Model – 1 Game - 3

The Nash Equilibrium reflects the result occurring in real life, where we see hardworking students completing the assignment alone. The occurring situation also reflects the free–rider problem, where an individual benefits from a good or service without contributing their fair share towards it. In this case, the unmotivated student often free–rides on the work produced by the hardworking students.

Model 2:
Utility derived when working as a team is usually not influenced just by the grade or leisure. It is influ-

enced by several factors, including the efficiency, distribution of workload and quality of teamwork. This can be modelled by

$U = \alpha\ grade_i + \beta\ leisure_i + \gamma\ efficiency_i + \delta$ distribution of $work_i$

Where $\alpha, \beta, \gamma, \delta \in [\ 0\ ,\ 10\ ]$

For a hardworking student, α might be the highest, while for an unmotivated student, β might be the highest.

Game 1:

Let this game have two hard-working students.

Let α = 10, as hardworking students give their highest priority to their grades. The team will receive the grade if at least one student completes the work, and hence even if one procrastinates, if the other works, the team will get the utility equal to the grade.

Let β = 5 for the hardworking students. They will get this utility if they procrastinate.

Let γ = ± 3, for efficiency of work. When the players are efficient in their work, they gain an extra utility of 3. If the work is inefficient, they lose a utility of 3 points.

Let δ = ±3 for the distribution of work. If the distribution of work is fair, they get an additional utility of 3. This occurs when both players do the work. The work distribution becomes one even when one of the players procrastinates, resulting in a fall of utility by 3 points for the player who does the work.

Here, gamma and delta are given equal weightage because both of them matter equally. However, they are less than the utility they derive from procrastinating because they are the factors that influence the quality of work *if* the player(s) work. They do not play a role to the player who procrastinates. But they are important factors for the player who does the work, and hence given the value 3.

Let both the players be Hardworking students

		Player B	
		Procrastinate	Does the work
Player A	Procrastinate	(5,5)	(15,4)
	Does the work	(4,15)	(16,16)

Table 7: Model – 2 Game - 1

When Player A procrastinates, the best response for Player B is to procrastinate as well. When Player A does the work, the best response for Player B is to do the work. As there is no common best response strategy, there is no dominant strategy for Player B. When Player B procrastinates, the best response for Player A is to procrastinate as well. When Player B does the work, the best response for Player A is to do the work. As there is no common best response strategy, there is no dominant strategy for Player A.

When both of the players procrastinate, they get a utility of 5 each from the leisure time. When one of the players procrastinates, the other student works and finishes the task. Hence, both of them receive a utility of 10 each. However, for the student who completes the task, this utility is partially offset by the uneven distribution of workload and the reduction in the efficiency of the work. Hence, for the student who does the work, the net utility will reduce from 10 to 10 – 3 - 3 = 4. However, the person who procrastinates will receive the net utility of 10 + 5 = 15. If both students do the work, they gain maximum utility from efficiency, distribution of workload, and completion of the task.

Here, the Nash equilibria are (Procrastinate, Procrastinate) and (Does the work). This model reflects better with reality better, as even hardworking students can be demotivated to work if the other student free rides on their hard work, but can work hard when both members put equal effort and complete the task more efficiently.

To calculate the mixed strategy equilibrium:

Let the probability of choosing to work be p for Player A and procrastinating be $(1–p)$. Similarly, let the probability of choosing to work be q and procrastinating be $(1–q)$ for player B.

If player A chooses to procrastinate, the expected payoff will be

$$5q + 15(1 - q)$$

If player A chooses to do the work, the expected payoff will be

$$4q + 16(1 - q)$$

For player A to be indifferent between procrastinating and doing the work,

$$5q + 15(1 - q) = 4q + 16(1 - q)$$
$$\Rightarrow 15 - 10q = 16 - 12q$$
$$\Rightarrow 2q = 1$$
$$\Rightarrow q = ½$$

For Player A to be indifferent between procrastinating and doing work, Player B should be choosing either of the options with a probability of 1/2

Similarly, for Player B to be indifferent between procrastinating and doing work, Player A should choose either of the options with a probability of 1/2.

Therefore, the mixed strategy Nash equilibrium occurs when Player A randomises between strategies with probabilities of ½ each and Player B randomises between the strategies with probabilities of 1/2 each.

At this equilibrium, both players are indifferent between their available strategies, as their expected payoffs are equal. Hence, no player has an incentive to deviate, satisfying the conditions of a Nash Equilibrium unilaterally.

Game 4:

Let the players of the game be hardworking student, and unmotivated student, with utility function

$U = \alpha \text{ grade}_i + \beta \text{ leisure}_i + \gamma \text{ efficiency}_i + \delta \text{ distribution of work}_i$

Let Player A be a hardworking student, and Player B be an unmotivated student

For the hardworking student, let

$\alpha = 10$

$\beta = 5$

$\gamma = \pm 3$

$\delta = \pm 3$

For the unmotivated student, let

$\beta = 10$, because the maximum utility an unmotivated student can gain from is leisure time.

$\alpha = 5$, because the unmotivated student, even though unmotivated, is still a student, and will gain utility from good grades.

$\gamma = 0$, because efficiency does not matter.

$\delta = 0$ or -3, as the equitable distribution of workload does not serve as a determinant of satisfaction. However, if an unmotivated student is assigned a greater amount of workload, this student is likely to experience increased dissatisfaction, resulting in a decrease in utility by three points.

	Player B

		Procrastinate	Does the work
Player A	Procrastinate	(5,10)	(12, 2)
	Does the work	(4, 15)	(13, 8)

Table 8: Model – 2 Game - 2

Here, when Player A procrastinates, she gets a utility of 5, while Player B gets a utility of 10 for the same. When Player A does the work and Player B procrastinates, Player B gets a utility of 10 for leisure and 5 for work, while Player A's utility for the work, which is 10, is offset by inefficiency and uneven distribution of workload. When both players complete the task, Player A gets the utility of 10 for the completion of the task and 3 for the fairness of workload distribution. However, Player B receives only 5 for the completion of tasks and 3 for the fairness of workload distribution. When Player A procrastinates and Player B completes the tasks, Player A gets the utility of 5 for leisure, and only 7 from task completion, since Player B is unmotivated and doesn't produce work of much quality when working alone or with other unmotivated students. Player B, on the other hand, receives a utility of 5 for task completion, which is offset by the negative utility of 3 for uneven distribution of work.

As Player B – the unmotivated student has a dominant strategy to procrastinate, Player A's best response will be to procrastinate. Hence, the Nash equilibrium will be to (Procrastinate, Procrastinate).

Game 5:

Let this game have two unmotivated students as Player A and Player B, with the utility function

$U = \alpha \text{ grade}_i + \beta \text{ leisure}_i + \gamma \text{ efficiency}_i + \delta \text{ distribution of work}_i$

With $\alpha = 5$

$\beta = 10$

$\gamma = 0$ or -3

$\delta = \pm 3$

		Player B	
		Procrastinate	Does the work
Player A	Procrastinate	(10,10)	(15, 2)
	Does the work	(2, 15)	(8,8)

Table 9: Model – 2 Game - 3

Here, when both players procrastinate, they get their maximum utility of 10 each. When both of them do the work, they get a utility of 8 each for completing the task and a fair distribution of work. When one of the players procrastinates, they get a utility of 10 for leisure, and also 5 for the grade, while the player who does the task gets a net utility of 2 due to the uneven distribution of work. The Nash Equilibrium for this game is (Procrastinate, Procrastinate)

RESULTS AND DISCUSSIONS

RESULTS:

Our analysis began with two models. In Model 1, utility was derived as a function of leisure and grade. When both players are unmotivated, the dominant strategy for both players is to procrastinate, resulting in the Nash equilibrium where neither of the players completes the task. When both players are hardworking students, the dominant strategy and hence the Nash equilibrium for both of them is to complete the task at hand. In a mixed pair, the hardworking student typically completes the task at hand, while the unmotivated student free–rides.

In model 2, we expanded the utility function to include efficiency of work and distribution of workload. This model demonstrated that even for hardworking students, working alone or bearing a comparatively higher portion of the work can be very demotivating. For instance, both students benefited from leisure when they procrastinated, but only one student's utility was reduced due to inefficiency and an unfair workload. Additionally, our analysis revealed that both hardworking and unmotivated students tend to randomise between strategies when there is no dominant strategy.

Discussions:

These results align closely with observed behaviours in academic settings. When hardworking students are teamed together, the task is often finished promptly without any delay or inefficiency. When two unmotivated students are paired together, the task is often left unfinished. When an unmotivated student is teamed with a hardworking student, the hardworking student often bears the job of completing the assignment alone, resulting in dissatisfaction and demotivation over time. This also reflects the problem of free riding. Further, these results demonstrate a crucial thing: the priority or the utility each student gives to different aspects of the task also matters when a student or a player, in this case, chooses between strategies.

Limitations

This study is theoretical and relies on simplified models, while student interactions are full of complexities that are often ignored when we attempt to capture them into one standard model. Further, the utility values assigned to different factors are heavily influenced by my personal experiences as a student. They vary widely from student to student. Also, the model assumes rational decision–making, whereas actual student behaviour is also influenced by the then emotional and mental state of mind, peer pressure, and other socio-cultural factors. The findings may not generalise to all educational settings, particularly those with different cultural attitudes toward teamwork and academic achievement. Further research can incorporate empirical data to validate and refine the models, and also explore additional factors that influence procrastination and task completion in academic collaborative contexts.

Conclusion

Procrastination is a prevalent problem, especially in teenagers in academic contexts. They often intervene in students' lives and academics, with negative consequences. Procrastination especially takes place when working as a team, resulting in free–riding and demotivation. Despite all these negative outcomes, students still choose to postpone their assignments, homework, etc. It is found that when unmotivated students are paired together, procrastination is the dominant strategy, resulting in incomplete tasks. Conversely, hardworking students, when paired together, finish the task assigned promptly. In mixed duos, the hardworking student assumes responsibility while the unmotivated student free-rides. This is also seen to demotivate the hardworking student from assuming responsibility. An extended model also includes factors other than task completion and leisure time, including efficiency and distribution of workload. These results provide a theoretical foundation for understanding the dynamics of postponing and task completion in students and provide avenues for better and effective teamwork and collaboration.