A Penalty Scheme for Academic Dishonesty

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***Abstract*— This work contributes to better understanding of the optimal penalties for the deterrence of academic dishonesty. Academic dishonesty has recently become one of the most prevalent issues in higher education [1]. In order to address this issue, researches have focused on understanding cheating methods and techniques, determinants, punishment, and consequences. Unlike common descriptive, exploratory or regression-based approaches proposed in the literature, this work proposes a mathematical framework for analyzing the optimal academic dishonesty penalties. Results suggest that expected penalties should be more than the possible gain in grades obtained by committing an offense. Moreover, it shows that increasing penalties are not always optimal for dealing with repeat cheats.**

Keywords*— *Cheating, Penalty Scheme, Plagiarism, Deterrence, Academic Policy.

I. INTRODUCTION

Recent studies have indicated that the severity of academic dishonesty has reached an alarming level worldwide, and top ranked universities are no exception. Cheating among university students is an international phenomenon in all disciplines, although higher rates were reported in Business, Engineering and Humanities [2]. According to [3], up to 75 percent of students admitted cheating at least one time during their education years. The situation is worse in some disciplines; according to [4], 96 percent of undergraduate engineering students admitted that they got involved in a cheating act. Research done in engineering and economics reports higher rate of cheating among students in these fields [5,6,7].

The prevalence of dishonesty in academia has motivated researchers to investigate its driving factors. According to [8], students who cheat are the ones with less academic ability or who believe that instructors are not able to pass on the material. Authors in [2] relate it to students' lack of time management skills or background knowledge on the subject. It was claimed in [9] that students in competitive situations would cheat to achieve success. Other researchers found that cheating is related to age, ethnicity, participation in institutional clubs or sport teams, grades and maturity [10]. Student personality and attitude toward the instructor and the course were among considered factors [2]. Other important factors also highlighted by [2] and several studies cited therein are the risk and consequences of being caught cheating.

Various approaches have been proposed for dealing with cheating. According to [11], cheating can be reduced at different rates through verbal warnings on the consequences of cheating and giving open-ended questions. Authors of [12] believed that cheating can be reduced by using essay questions. Other researchers including [13] suggest that schools should provide students with and explain a clear honor code to help reduce cheating. Authors of [14] recommend that universities should support faculties who report cheating acts. Work in [15] found that implementing technology in the classroom has positive impact on students' attitudes towards cheating. It was claimed in [16] that students should be aware of the high chance of being caught if they decided to cheat. The negative correlation between propensity for cheating, and the probability of being caught and severity of penalties is a commonly reported result [3], [7], [17].

Research results have shown that academic unethical behavior starts at some point throughout the years of education and have long-term impact on students' behavior [4]. Authors in [18] believe that such students are potential shoplifters and authors of [19, 20] believe that these students could behave unethically at work. Researchers also claimed that students who cheat once find it easier to cheat again. 42 percent of college students who were caught cheating admitted that they were involved in cheating multiple times [21]. Work in [4] found that engineering students have the tendency to cheat more in college if they cheated in high school and they would cheat more in the future.

The literature clearly highlights the importance of the penalties and experience in previous incidents on student's decisions to cheat. Exploratory, descriptive and regression-based studies focus on identifying determinants of unethical behavior in academia rather than providing suggestions on how such determinants can be designed to deter students from being engaged in such behavior. If controllable determinants can be designed, educators and university policymakers can optimize them in-order to control students' unethical behavior. In a framework that captures students' behavior over two periods and decision process in reaction to penalties, we provide insights on how penalties can be optimized.

The remainder of the paper is organized as follows. Section II describes the student behavior model. The decision-making process is presented in Section III. In Section IV, the optimal deterrence strategy is derived. Finally, concluding remarks are made in Section V.

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II. STUDENT BEHAVIOR MODELING

The proposed framework captures a common academic setting that applies at most academic institutions. A large number of academic institutions around the world publishes their academic discipline policies on their websites and in their academic catalogs. Policies include academic principles, various academic and non-academic offenses, and the corresponding penalties. Thus, students are aware of the possible penalties before making a decision to commit an offense. A number of different factors affects students' attitudes towards cheating; however, the common objective is improving their grades. The extra grades g derived by committing an offense varies from one student to the other; this is captured by the grades distribution function $Z(g)$ where $g \in [0, \bar{g}]$. $\bar{g}$ symbolizes the maximum achievable gain in terms of grades. The instructor or teaching assistant (TA) detects academic offenses with probability $p(r)$ where r is the reward gained by detecting an offense. With the large number of assessments they have to grade, teaching assistants might find checking for cheating and awarding zero for the whole assessment, easier than grading it and providing feedback to students. This is particularly true in science and engineering courses where detecting cheating is as simple as comparing lines of code or comparing chosen mathematical variables. An engineering TA believes that "Grading homework is so fast when they (students) all cheat and use the illegal solutions manual," [22]. Therefore, the reduction in TA's workload can be considered as a reward, r, that is equivalent to grades summation of reported assessments, i.e., the ones that the TA avoids grading. This implies that the detection probability is an increasing function of r.

In order to capture the variation in students' behaviors over time, three types of students are considered: students of integrity who never violated the code of academic integrity (Type-$\mathcal{J}$); Students who have committed an academic offense at least once but were never caught (Type-$\mathcal{NC}$); Students who were caught at least once (Type-$\mathcal{C}$). The general approach adopted for modeling students' behavior is based on work in [23] which models law offenders' behavior and decision process. High correlation among students' previous, current and future unethical behaviors has been reported in [15, 18, 19, 20]. Figure 1 shows the alternative scenarios students have over two-periods[1]. In the first period, all students are assumed to start as type $\mathcal{J}$ students. The probability of detecting an offense committed by type $\mathcal{J}$, $\mathcal{NC}$ and $\mathcal{C}$ student is denoted by $p^{\mathcal{J}}(r)$, $p^{\mathcal{NC}}(r)$ and $p^{\mathcal{C}}(r)$, respectively. From TA's perspective, type-$\mathcal{J}$ and type-$\mathcal{NC}$ students are indifferent because the offense was not detected; these types of students are referred to by clean-record $\mathcal{CR}$ students. The above description is illustrated in Figure 1. A penalty $f^{\mathcal{CR}}$ is imposed when a type-$\mathcal{CR}$ student commits an academic offense and $f^{\mathcal{C}}$ for type-$\mathcal{C}$ students. This work focuses on finding the optimal $f^{\mathcal{CR}}$ and $f^{\mathcal{C}}$ in a penalty scheme that aim at maximizing the level of academic integrity among students.

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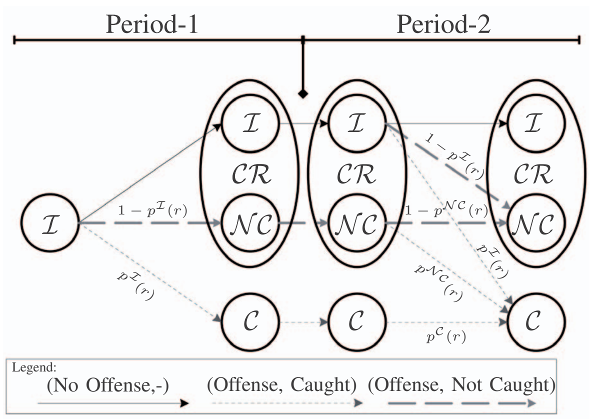
[1] A period refers to a time period of an arbitrary duration over which a student makes a decision about committing an academic offense.

[2] In the economics of crime literature, the term efficient offense refers to

Fig. 1 A Diagram illustrating students possible types over two periods. The arrow style refers to one of the following: First, a student decides not to commit an offense; second, a student commits an offense and got caught by TA; third, a student commits an academic offense but was not caught. The term over the arrow indicates the probability of detecting an offense for a given type.



Students learn and develop their cheating skills with the number of academic violation incidents they commit. They learn how to avoid the TA's techniques employed in checking for cheating and plagiarisms [21]. This is confirmed in a type-$\mathcal{C}$ student's assessment of education "It's like, you (are) not really there to learn anything. You (are) just learning to learn the system" [24]. Students learn how to modify the copied approach, mathematical variables, assumptions and wording to make it different than the plagiarized work in order to avoid the TAs cheating detection mechanisms. In comparison to type-$\mathcal{J}$ students, students who committed the offense and were not caught, type-$\mathcal{NC}$, learn that their approach in avoiding the detection mechanism is successful. Similarly, students who are caught cheating *might* learn further more about the details of the detection mechanisms and utilize this knowledge in avoiding them in the future. Therefore, the three detection probabilities can be related by $p^{\mathcal{C}}(r) \leq p^{\mathcal{NC}}(r) \leq p^{\mathcal{J}}(r)$. The decrease in detection probability from $p^{\mathcal{J}}(r)$ to $p^{\mathcal{NC}}(r)$ is proportional to the knowledge gained by a student $K^{\mathcal{J}}_{\mathcal{NC}}$. In a similar manner, the knowledge gained from being caught cheating, denoted by $K^{\mathcal{NC}}_{\mathcal{C}}$, is proportional to the reduction in the detection probability from $p^{\mathcal{NC}}(r)$ to $p^{\mathcal{C}}(r)$. On the other hand, the TA blacklists students who were caught cheating and carefully checks their subsequent submissions; this increases the probability from $p^{\mathcal{C}}(r)$ to $p^{\mathcal{C}+}(r)$. This increase is proportional to the knowledge, K^{TA}, gained by the TA about misbehaving students.

III. ACADEMIC OFFENSE DECISION-MAKING

A student decision about committing an offense in either of the periods depends on the expected payoff gained in terms of grades. A student would cheat in a given period if and only if the grade gain is greater than the expected penalty. In specific, a student of type-$\mathcal{J}$ commits an academic offense iff $g > p^{\mathcal{J}}(r) \times f^{\mathcal{CR}} + (1 - p^{\mathcal{J}}(r)) \times 0$. Similarly, $\mathcal{NC}$ and $\mathcal{C}$ students commit an offense iff $g > p^{\mathcal{NC}}(r) f^{\mathcal{CR}}$ and $g > p^{\mathcal{C}+}(r) f^{\mathcal{C}}$, respectively. Table I tabulates students' various decisions in period-1 and period-2, the possible consequences, and corresponding penalties. An offense committed by a student in period-1 would be either detected by the TA with probability $p^{\mathcal{I}}(r)$, or not detected with probability $1 - p^{\mathcal{I}}(r)$. Because in period-1 all students start of type-$\mathcal{I}$, the penalty is $f^{\mathcal{CR}}$. Thus, the resulting expected payoff is

$$[g - p^{\mathcal{I}}(r) f^{\mathcal{CR}}]^{+}, \quad (1)$$

where$[\,\cdot\,]^{+} = \max(\,\cdot\,,0)$. With reference to Table 1, both caught and not caught students have two possible decisions in the second period: commit the offense or refrain from it. The expected payoffs in the second period depend on students' previous behavior, which determine the detection probability and penalty. The different expected payoffs are tabulated in the second last row of Table I.

Decision variables described above model students' decisions in a specific period, for a given penalty, and history. This is limited to independent incidents at which students decide to cheat in a particular scenario. For instance, a student who lacks the time management skills tends to cheat when being under pressure to meet multiple deadlines [2]. We are further interested in modeling the behavior and decision process of students who adopt cheating as an approach to improve their grades. This can be achieved by considering students possible type change, penalties and payoffs over both periods. For a student committing an academic offense in the first period and making either of the subsequent decisions in the second period, the expected payoff over both periods is

$$P_O = [g - p^{\mathcal{I}}(r) f^{\mathcal{CR}}]^{+} + p^{\mathcal{I}}(r)[g - p^{\mathcal{C}+}(r) f^{\mathcal{C}}]^{+} + \big(1 - p^{\mathcal{I}}(r)\big)[g - p^{\mathcal{NC}}(r) f^{\mathcal{CR}}]^{+}. \quad (2)$$

However, students who decide not to commit the offense in the first period would have an expected payoff equivalent to

$$P_{NO} = [g - p^{\mathcal{I}}(r) f^{\mathcal{CR}}]^{+}, \quad (3)$$

over both periods. Being aware of penalties published by the university, students compare the expected payoffs in (2) and (3) to decide on adopting the cheating approach in the first period, if $P_O > P_{NO}$. Knowing students' decision process and behavior, university policy-makers and instructors decide on $f^{\mathcal{CR}}$ and $f^{\mathcal{C}+}$ to deter cheating and promote academic integrity.

IV. Optimal Deterrence Strategy

Although committing an academic offense results in a number of intangible negative consequences, in this work we are interested in measurable and tangible ones. In academic settings, where instructors curve-fit students' grades to a certain distribution or scale grades to meet a predefined grades-average, students' grades are correlated. In such competitive environment, an increase in one student or a group of students' grades inflates class average and decreases the rest of the students' grades. In addition, type-$\mathcal{I}$ students might be discouraged from studying when cheating students are getting higher grades; this has a negative impact on their performance and degrades their grades. We refer to the reduction of students' grades due to academic offenses committed by others as the harm, h. Teaching assistants strong temptation to reduce their workload by detecting academic offenses increases the detection probability. The detection probability is an increasing function of the reward r, which is equivalent to the summation of all reported assessments methods grades; hence, students' grades are reduced by r.

In this section we propose a public-enforcement-of-law [25] based approach to maximize students' academic welfare. We introduce the term *academic welfare* to refer to the grades gain students achieve from their academic decisions and behavior, less the harm caused to the class, and less the reward gained by the TA. The achieved gain is reduced by the harm, h, caused by their academic offenses and TAs' rewards, r. Students are assumed rational and risk-neutral in the sense that they commit the academic offense if and only if the obtained gain exceeds the expected penalty. In other words, academic offenses are committed $iff\;\; g > p^{\mathcal{I}}(r) f^{\mathcal{CR}}$ for type-$\mathcal{I}$, $g > p^{\mathcal{NC}}(r) f^{\mathcal{CR}}$ for type-$\mathcal{NC}$, and $g > p^{\mathcal{C}+}(r) f^{\mathcal{C}}$ for type $\mathcal{C}$. As a result, over both periods, students adopt the cheating approach if $P_O > P_{NO}$. Based on the above description, the academic welfare function can be captured by,

$$\int_{p^{\mathcal{I}}(r) f^{\mathcal{CR}}}^{\bar{g}} (g - h) Z(g)\, dg + \int_{p^{\mathcal{I}}(r) f^{\mathcal{CR}},\, p^{\mathcal{NC}}(r) f^{\mathcal{CR}},\, p^{\mathcal{C}+}(r) f^{\mathcal{C}}}^{\bar{g}} (g - h) Z(g)\, dg - r. \quad (4)$$

In the proposed framework, r and $p(r)$ are variables; therefore, a given expected fine, i.e., $p^{\mathcal{NC}}(r) f^{\mathcal{CR}}$ and $p^{\mathcal{C}+}(r) f^{\mathcal{C}}$, can be achieved by raising/lowering the penalty and lowering/raising the reward [25]. Although TAs have great temptation to increase their rewards r, it is limited to the total grades of assignments detected by the TA, $\max(r)$. The optimal TA rewards are not chosen by the college or department but rather by students' behavior. The more they cheat, the higher the reward r and the less the TA's workload. Lowering r corresponds to turning a blind eye to students' academic offenses and considered unethical. Conversely, raising r to the maximum possible valueis educationally desirable and increases the level of integrity. The optimal r is therefore chosen to be $r^* = \max(r)$, that is the maximum sum of grades corresponding to all reported assignments. This implies optimal detection probabilities given by, $p^{\mathcal{I}}(r^*)$, $p^{\mathcal{NC}}(r^*)$ and $p^{\mathcal{C}+}(r^*)$.

A student wealth of grades, w, is considered to be the cumulative sum of assessment methods grades; w is larger than the possible harm caused and penalties to be imposed. In the economics of crime literature, incorporating the benefits to crime in the social welfare function has been considered controversial [26], [27]. For example, including money stolen

TABLE I
A TABLE SHOWING STUDENTS POSSIBLE DECISIONS, DETECTION OUTCOMES, PENALTIES, AND CHEATING INCURRED PAYOFF.

Period	Stage									
↓ Period-1	Decision ↓[a]	Offense						No Offense (NO)		
	Detection ↓	Caught (C) with Probability $p^{\mathcal{I}}(r)$			Not Caught (NC) with Probability $1-p^{\mathcal{I}}(r)$			-		
	Penalty ↓	$f^{\mathcal{CR}}$			Zero			-		
	Payoff ↓	$\left[g-\left(p^{\mathcal{I}}(r)f^{\mathcal{CR}}+(1-p^{\mathcal{I}}(r))\times \text{Zero}\right)\right]^{+}=\left[g-\left(p^{\mathcal{I}}(r)f^{\mathcal{CR}}\right)\right]^{+}$						-		
↓ Period-2	Decision ↓	Offense		NO	Offense		NO	Offense		NO
	Detection ↓	C, $p^{\mathcal{C}+}(r)$	NC, $1-p^{\mathcal{C}+}(r)$	-	C, $p^{\mathcal{NC}}(r)$	NC, $1-p^{\mathcal{NC}}(r)$	-	C, $p^{\mathcal{I}}(r)$	NC, $1-p^{\mathcal{I}}(r)$	-
	Penalty ↓	$f^{\mathcal{C}}$	Zero	-	$f^{\mathcal{CR}}$	Zero	-	$f^{\mathcal{CR}}$	Zero	-
	Payoff ↓	$\left[g-p^{\mathcal{C}+}(r)f^{\mathcal{C}}\right]^{+}$		-	$\left[g-p^{\mathcal{NC}}(r)f^{\mathcal{CR}}\right]^{+}$		-	$\left[g-p^{\mathcal{I}}(r)f^{\mathcal{CR}}\right]^{+}$		-
Both periods expected payoff		$\left[g-p^{\mathcal{I}}(r)f^{\mathcal{CR}}\right]^{+}+p^{\mathcal{I}}(r)\left[g-p^{\mathcal{C}+}(r)f^{\mathcal{C}}\right]^{+}+(1-p^{\mathcal{I}}(r))\left[g-p^{\mathcal{NC}}(r)f^{\mathcal{CR}}\right]^{+}$						$\left[g-p^{\mathcal{I}}(r)f^{\mathcal{CR}}\right]^{+}$		

[a] Arrow points to subsequent event in the process.

from a bank in the social welfare seems unethical and socially undesirable. From academic perspective, counting all students grades towards the class average is a common practice. Thus, including academic offense incurred grades in the academic welfare function in (4) is completely uncontroversial. Another uniqueness of the academic settings is that the harm-relative excess of gain does not compensate for the harm caused and even efficient offenses[2] are not desirable. In other words, although the extra grades derived from an academic offense could be larger than the loss in other students' grades, it would not be redistributed to other students to compensate for the harm caused. On the basis of these conditions, complete deterrence is optimal especially when high enforcement cost, r, is desirable. The university academic policymakers and professors maximize the academic welfare in (4) while aiming for complete deterrence through optimizing penalties denoted by $f^{*\mathcal{CR}}$ and $f^{*\mathcal{C}}$.

Given the academic welfare function in (4), complete deterrence can be achieved with expected penalties equivalent to, or higher than, the maximum possible gain. Mathematically, complete deterrence can be achieved when

$$p^{\mathcal{J}}(r^*)f^{\mathcal{CR}} \geq \bar{g},$$
$$p^{\mathcal{NC}}(r^*)f^{\mathcal{CR}} \geq \bar{g}, \text{ and}$$
$$p^{\mathcal{C}+}(r^*)f^{\mathcal{C}} \geq \bar{g}.$$

Since $p^{\mathcal{CR}}(r^*) \leq p^{\mathcal{J}}(r^*)$, the optimal penalties are as follows:

$$f^{*\mathcal{CR}} \geq \frac{\bar{g}}{p^{\mathcal{NC}}(r^*)} \tag{5}$$

$$f^{*\mathcal{C}} \geq \frac{\bar{g}}{p^{\mathcal{C}+}(r^*)}. \tag{6}$$

[2] In the economics of crime literature, the term efficient offense refers to offenses that results in a gain greater than the harm caused.

With reference to payoffs in (2) and (3), it is clear that with penalties in (5) and (6), students' expected payoff is zero which is inadequate for committing an academic offense.

The ultimate objective of academic policies is to discourage students from committing academic offenses rather than lowering their grades average. Therefore, an adequate set of expected penalties would be the lowest possible, that is $p^{\mathcal{NC}}(r^*)f^{*\mathcal{CR}} = \bar{g}$ and $p^{\mathcal{C}+}(r^*)f^{*\mathcal{C}} = \bar{g}$. It was established in Section 2 that $p^{\mathcal{NC}}(r^*)$ decreases to $p^{\mathcal{C}}(r^*)$ by a magnitude proportional to $K_{\mathcal{C}}^{\mathcal{NC}}$. The latter increases to $p^{\mathcal{C}+}(r^*)$ by an amount proportional to K^{TA}. On the basis of these observations, the severity of the fines can be related to student's record of academic offenses and amount of knowledge gained with respect to cheating and detection by the student and TA, receptively. Both expected fines are equal to the maximum possible gain $\bar{g}$; thus, a decrease in probability enforces an increase in penalty and vice versa. At the same time, the decrease in probability is controlled by the knowledge gained. If the knowledge gained by the TA is less than the one gained by the student, $K^{TA} < K_{\mathcal{C}}^{\mathcal{NC}}$, then $p^{\mathcal{C}+}(r^*) < p^{\mathcal{NC}}(r^*)$ and the penalty increases from $f^{*\mathcal{CR}}$ to $f^{*\mathcal{C}}$. Conversely, if $K^{TA} > K_{\mathcal{C}}^{\mathcal{NC}}$, the penalties are related by $\frac{\bar{g}}{p^{\mathcal{C}+}(r^*)} \leq f^{*\mathcal{C}} \leq f^{*\mathcal{CR}}$. It is interesting to note here that increasing penalties are not always optimal for recurrent offenses when the knowledge gained by the offender and academic policy enforcer is considered. The practical implications of these results can be described in the following: First, if students' cheating skills improve beyond a level at which the TA can easily detect them (low detection probability), the increasing penalty would be optimal; thus, the higher the penalties, the higher the deterrence. Second, if the TA's knowledge of students cheating techniques and detection skills improve to point where an offense would be detected with high probability, then fixed penalties would be adequate, i.e., $f^{*\mathcal{C}} = f^{*\mathcal{CR}}$.

V. CONCLUSIONS

This paper provided a framework that models students cheating behavior and decision process over two periods. It captures common academic settings that apply at most academic institutions. Cheating detection probability, grades gain, grader incentive, and cheating record are among considered parameters. It's assumed that students are rational and risk-neutral who cheat if their grade gain is higher than the expected penalty. Two major results are presented: First, complete deterrence is achieved when the expected penalty is higher than the maximum possible gain. Second, increasing penalties are not always optimal to punish repeat cheaters when cheaters and teaching assistants learning is considered.

It should be noted that this study has been primarily concerned with rational and risk-neutral students only. Our future work will focus on irrational students who would commit an offense irrespective of how high is the penalty or grades gain.

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