Detection, Patterns, Consequences, and Remediation of Electronic Homework Copying

by

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B.S., Mechanical Engineering (1996)

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Submitted to the Department of Physics
in Partial Fulfillment of the Requirements for the
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at the

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The log of all interactions the student makes with an online homework tutor (MasteringPhysics), including start time, finish time, correct answers, wrong answers, and hints requested allowed the development of an algorithm which assigns a "copying" probability to each problem completed. This algorithm was applied to three successive Newtonian Mechanics classes at MIT: Fall 2003, Fall 2004, and Fall 2005, affording unique insight into the dynamics of physics homework copying, and allowing contrasts between the performance and behavioral patterns of students who copy a lot and students who copy a little or copy none at all. Observations show that repetitive homework copying is correlated with steeply declining exam performance, and that repetitive copiers are four times more likely to fail to complete the required two semester physics sequence on time than students who don't copy. Observations of several behavioral patterns associated with repetitive homework copying are reported – these patterns, combined with data from a self-reported cheating survey of MIT freshman, shed new light on the reasons students copy and steps educators can take to reduce homework copying. Through the implementation of several of these steps, we observe that between Fall 2003 and Fall 2005 detected homework copying dropped by ~40%. Although efforts to reduce homework copying may not be an innovation in teaching, our study indicates it may be the best path to increasing student learning and success.

Thesis Supervisor: David E. Pritchard

Title: Cecil and Ida Green Professor of Physics

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I would also like to thank Eric Hudson for allowing us to survey the Spring 2006 8.02 Teal students; Alberta Lipson for providing the 1992 Freshman academic dishonesty data; Marilee Jones and Matt McGann for providing admission data for the 2003 - 2005 8.01 students; and Ri Romano for providing academic transcript data for the 2003 - 2005 8.01 students.

Lastly, thank you Leila for your loving support throughout my Army career, and especially during our time in Boston.

Contents

List of Figures

3-14: S-R cheating tolerance vs. S-R cheating frequency

3-15: S-R cheating tolerance vs. S-R 8.01 HW copying

3-16: S-R high school HW copying vs. S-R 8.01 written HW copying

List of Tables

1 Collegiate Academic Dishonesty: A Fifty Year Review

As long as there have been graded requirements, there have been cheaters-people who, tempted by the rewards or the convenience of the act, have sought to find an easy solution to a hard question. Two thousand years ago, Imperial Chinese went to great lengths to curb cheating on civil service exams only to find that examinees invented increasingly clever ideas to beat the system [10]. Modern students are, in many ways, similar to the Chinese civil servant. They both cheat(ed) for gain. And, they both use(d) increasingly clever means of cheating. Three thousand years ago, Chinese civil servants would sew crib notes into hidden pockets within their clothing; today's student often relies on technology.

This chapter will review five aspects of the modern cheating literature:

I. Forms and prevalence of academic dishonesty
II. Individual and environmental factors associated with students engaging in academic dishonesty
III. Psychological and social theories forwarded to explain cheating behaviors
IV. Methods of cheating detection (specifically multiple-choice exams and term papers)
V. Literature Review of Cheating Remediation

This chapter seeks to provide the reader an overall perspective on academic dishonesty. It will attempt to answer the following questions based on the relevant literature:

1.) What are the various forms of cheating? How are they defined? Is cheating increasing? If so, which forms? What might account for these increases?
2.) How do various demographic factors affect academic dishonesty?
3.) Why do students cheat?
4.) What methods have been developed for detecting cheating students?
5.) What methods have researchers tried in order to reduce cheating?

1.1 Forms and Prevalence of Academic Dishonesty

This section will summarize data from over 120 cheating studies conducted from 1955 to 2005. Through a comprehensive examination of these studies, we attempt to answer the following:

1. How is academic dishonesty defined?
2. What methods have researchers used to investigate academic dishonesty?
3. What are the advantages and disadvantages of each method?
4. What do these studies conclude about the prevalence of academic dishonesty?

One of the problems associated with researching a topic as broad as "academic dishonesty" is the lack of a concrete, standard definition. For this review, we define academic dishonesty using Lambert's [78] definition as "any fraudulent action or attempt to use unauthorized or unacceptable means in any academic work." Lambert goes further to classify four realms of academic dishonesty: cheating by using unauthorized means, fabrication of information, plagiarism, and facilitating academic dishonesty by helping other students engage in the first three. For purposes of our review, we separate Lambert's classification of academic dishonesty into the following 4 main groups and 11 separate forms of cheating:

- I. General Cheating
- II. Exam Cheating:
  - General
  - Copying From Another Student
  - Using Crib Notes
  - Helping Another Student Cheat
- III. Plagiarism
  - General Plagiarism from Exterior Sources
  - Copying Material Without Footnoting
  - Falsifying a Bibliography
- IV. Unauthorized Cooperation
  - Turning in Work Done by Another
  - Unauthorized Collaboration on an Assignment
  - Homework Copying

Detecting someone during the act of cheating remains a difficult proposition. Accordingly, very few, if any, students report being caught cheating [122], while we know that most studies report that many more students actually are cheating [95]. To date, researchers have relied on alternate means for data collection other than direct observation of all coursework.

Our review notes three cheating data collection methods used by researchers: self-reported surveys, experimental data collection, and the randomized response technique.

Self-reported surveys (88 studies). Self-reported surveys ask general questions regarding the frequency and severity of cheating, as well as the underlying causes of cheating. Influential self-reported cheating studies prior to 1990 include Goldsen et al.[44], Bowers (1964), Harp & Taietz [53], Baird [5], Haines et al.[48], Todd-Mancillas and Sisson [132-134], and Micheals & Miethe [97]. Between 1975 and 1990, an average of 1.5 studies was published each year (21 total). Following 1990, the volume of cheating studies has increased to 3 studies per year (45 total). Noteworthy researchers in the last 15 years include Don McCabe, Linda Trevino, Stephen Davis, George Diekhoff, and Valarie Haines. The major claims of the self-reported literature include:

- Academic cheating occurs at rates as high as 95% [19]
- Academic cheating is increasing [89]
- Demographic influences on academic cheating remain widely disputed

In the early 1980s, there was the perception among educators that cheating, particularly in college level institutions, was on the rise. In 1979 a Carnegie Council Report warned of the advent "ethical deterioration" in academics. Haines et al. [48] reported in 1990 that the levels of cheating were reaching "epidemic" proportions. In 1993, the U.S. Department of Education issued a monograph reviewing collegiate academic dishonesty. They recognized the inherent variability with regards to the cheating data; especially when comparing data sets sampled decades apart. Maramark and Maline [85] concluded that the current literature suggested cheating in college had become a "chronic problem." However, the data are not that simple to interpret. Large variance exists among all studies, with some researchers noting cheating levels as low as 3% [74] and some as high as 95% [19]. Regardless, the two claims above should disturb educators, parents, students, and society in general.

Reliability withstanding, there are several questions regarding the accuracy of self-reported data. We believe that self-reported survey data are questionable if only because these surveys are asking dishonest students to classify and quantify their dishonesty. Erickson [29] showed that self-reported cheating rates can differ from actual cheating rates by as much as 40%. We, and others, question the inherent reliability of self-reported data although those who employ it defend the method. Despite this shortcoming, Hollinger [58] believes that the self-reported survey is still the most applicable and insightful tool available to social science researchers, while Cizek [15] believes it is nonetheless "reasonably accurate". A reader should understand the external factors surrounding a survey before digesting its data.

Second, on what basis are researchers concluding that various forms of cheating are increasing? To date, only two purely longitudinal comparisons have been conducted. In 1990, Don McCabe began a series of multi-campus investigations into cheating within college institutions, conducting a longitudinal measure of changes in reported cheating behaviors against

Bower's 1964 study [89]. McCabe found that some forms of cheating were increasing, namely general cheating, exam cheating, and unauthorized collaboration, while others forms of cheating were stagnant. Haines et al. [48] and Deikhoff et al. [23] conducted the only other known longitudinal study of collegiate cheating. An initial study was conducted in 1984 at an unspecified Southeastern public university. A follow-up study, at the same institution, was conducted in 1994. Diekhoff found no statistical change in exam cheating, but noted statistical increases in overall cheating (+7%, $t = -2.08$, $p<.05$) and assignment cheating (+11%, $t = -3.42$, $p<.01$).

No author to date has attempted to digest all available data and analyze prevalence rates over time. Whitley [145] conducted a comprehensive review of cheating studies between 1970 and 1995 in an attempt to quantify overall cheating rates and identify contributing demographic factors, but did not correlate the data with time.

Randomized Response Technique (2 studies). In this procedure, respondents first flip a coin prior to being asked a question. If the result is "heads", the respondent is asked an innocuous question unrelated to cheating; "tails" and the respondent is asked a question regarding their cheating behavior. Only the respondent knows which question they were asked - the researcher uses the laws of probability to estimate how many students were asked the cheating question and how many responded that they had cheated.

Two studies located relied on the randomized response technique: Nelson and Schaefer [102] and Scheers and Dayton [117]. Scheers and Dayton reported that the randomized response technique shows that self-reported survey data underestimate actual cheating rates by as much as ~40%. Scheers and Dayton attribute this to the additional anonymity afforded students with the randomized response technique. Nelson and Schaefer [102] reported that when comparing the question "have you cheated on a college test at least once," 50% of students asked with a self-reported survey admitted they had cheated while only 12% of students asked with the randomized response technique admitted cheating. No explanation was given for this reversal. The failure of these studies to forward a consensus on the randomized response technique casts severe doubt on its reliability and usefulness.

Experimental Cheating (25 studies). The third data collection method used by researchers relies on using an experimental setup to measure student cheating. Each experiment was conducted by placing individual students in a compromising situation and measuring how many cheated. All of these 25 studies predate 1990. Ackerman [1] expressed his disapproval of this experimental technique because it involves a "deception" on the part of the investigator. See Appendix A for the complete list of the experimental studies collected. Most studies have large errors due to a small sample size. Overall study variance is high, with some studies reporting as many as 80% [14] of students engaging in cheating and some studies reporting as few as 3% [73] of students cheated. The mean of all 25 studies is 47.3% with a standard deviation of 20.3.

Sample for this Literature Review.

Our objective was to find and gather, if possible, all self-reported studies relevant to undergraduate cheating. The sample was collected using several databases. Computerized searches were made using Psychological Abstracts, Sociological Abstracts, Dissertation Abstracts, and ERIC (Educational Resources Information Center). Three previous cheating review papers also provided many sources: Whitley [145] Maramark and Maline [85], and Weber [142]. A comprehensive list of cheating literature maintained by the Center for Academic Integrity also assisted in compiling sources. Finally, by examining the bibliographies of each source, I discovered second and third-order sources that were missed by computerized searches. Studies were included if they reported the prevalence of cheating by undergraduate students in the U.S., Canada, Great Britain (U.K.), or Australia. Studies reporting prevalence of high school or graduate student cheating were not included for this analysis, but high school student data will be included in later analyses of factors associated with academic dishonesty. Rarely did a study report data on all 11 forms of academic dishonesty; most studies only concerned Cheating (General) or Exam Cheating (General). A total of 88 self-reported survey studies were used for this analysis, with the earliest study from 1960 and the latest study from 2005. Whitley's [145] review included a total of 46 studies on the prevalence of cheating with the earliest from 1971 and the latest from 1995; 1 study from Whitley's review was not included because it could not be located and 1 was not included because the data were not in analyzable format. An additional 15 studies were found between 1952 and 1970 and 29 more studies were found between 1996 and 2005. A complete list of the included studies can be found in Appendix 2.

Objectives, Procedures, and Analysis.

Our objective is to analyze data on 11 forms of cheating through the collection of published self-reported studies and determine whether each form of cheating is increasing over the previous fifty years. Percentages were recorded for each form of cheating above and plotted against the year of data collection. If a study did not indicate the year the data were recorded, it was assumed the data were collected the year prior to the date of publication. Pearson correlation coefficients were calculated for each form of cheating in order to measure how much, and in which direction, each form of cheating had changed over the last fifty years. An estimated error for each correlation was calculated using a bootstrap technique with 1000 trials; in each trial the data was resampled randomly and the correlation was recalculated. The bootstrap technique attempts to model the underlying distribution with an empirical distribution obtained through multiple resampling of the original data; Freedman et al. [150] showed the validity of the bootstrap method for estimating confidence intervals and regression errors.

Results.

Table 1 lists the form of cheating, the number of studies that contributed data, the Pearson correlation coefficient (r), the correlation error, the significance of the correlation (p-value), the slope of the correlation line, and the error of the slope. In 11 trials (the number of behaviors tabulated), the probability of observing $p = .002$ is $p = .022$. Therefore, we regard the increase of S-R Unauthorized Collaboration ($p < .002$) with time as significant, and the decline of S-R Turned In Work By Another ($p < .007$) as suggestive. None of the other behaviors tabulated are even suggestively changing with time.

Cheating Behavior	**N**	**r**	**Error(+/-)**	**p-value**	**Slope (%/century)**	**Slope Error (+/-)**
Self-Reported Cheating (General)	52	0.53	.11	0.0001	.007	.0015
Self-Reported Cheating (General) – w/o Goldsen et al.	51	.07	.21	.70	.001	.003
Self-Reported Exam Cheating(General)	33	-0.19	.22	0.3	-.004	.0037
Self-Reported Exam Cheating (Copying from another student)	23	-0.2	.18	0.36	-.0034	.0036
Self-Reported Exam Cheating (Helping another student cheat)	24	-0.18	.22	0.4	-.0028	.003
Self-Reported Exam Cheating (Using crib notes)	22	-0.43	.22	0.04	-.003	.0014
Self-Reported Copied Material w/o Footnoting	14	-0.14	.26	0.6	-.0015	.003
Self-Reported Plagiarism	26	-0.37	.15	0.06	-.0056	.0028
Self-Reported Plagiarism (Falsifying a Bibliography)	13	0.02	.20	0.95	.0002	.003
Self-Reported Turned in Work by Another	22	-0.55	.17	0.007	-.0028	.0009
Self-Reported Unauthorized Collaboration	16	0.69	.12	0.002	.012	.003
Self-Reported Homework Cheating	22	0.27	.22	0.23	.0071	.005

Table 1-1: Correlation of Cheating Behaviors with Time

Plots for S-R Cheating (General), Graph 1, S-R Exam Cheating (Using Crib Notes), Graph 2, and S-R Unauthorized Collaboration, Graph 3, are below. See Appendix D for each of the other plots.

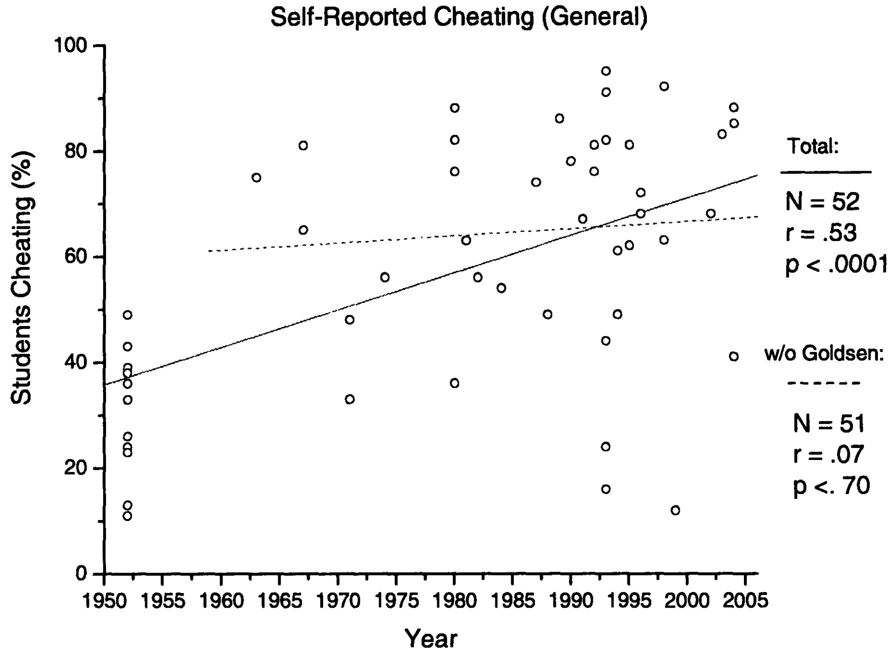

Figure 1-1: Self-Reported Cheating (General): The solid line shows that S-R Cheating (General) has increased ~1.6x between 1955 and 2005. However, excluding the Goldsen et al. (1960) study, S-R Cheating (General) shows no significant increase between 1965 and 2005 (dashed line).

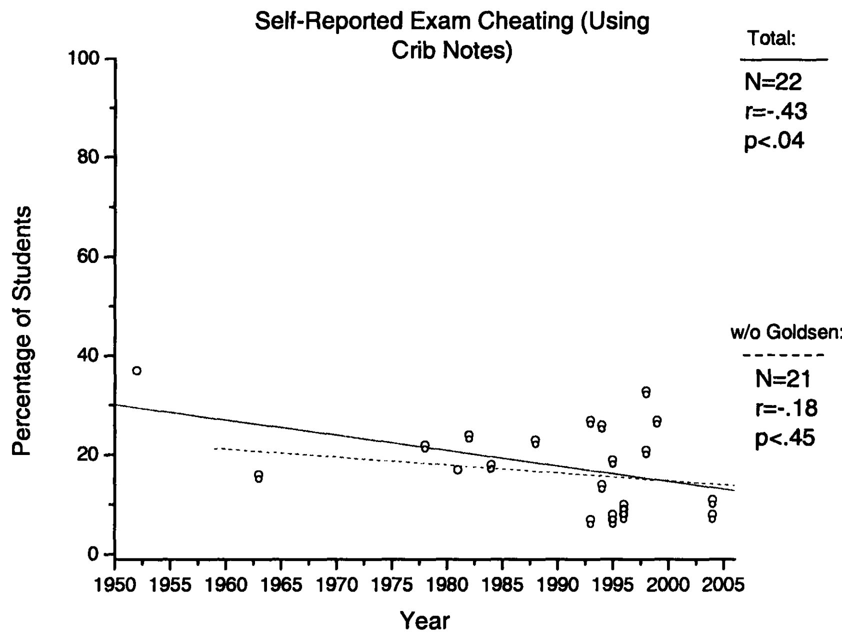

Figure 1-2: The solid line shows S-R Exam Cheating (Using Crib Notes) decreased by 2x between 1955 and 2005. With the Goldsen et al. study removed, no significant change is detected over the period 1965-2005 (dashed line).

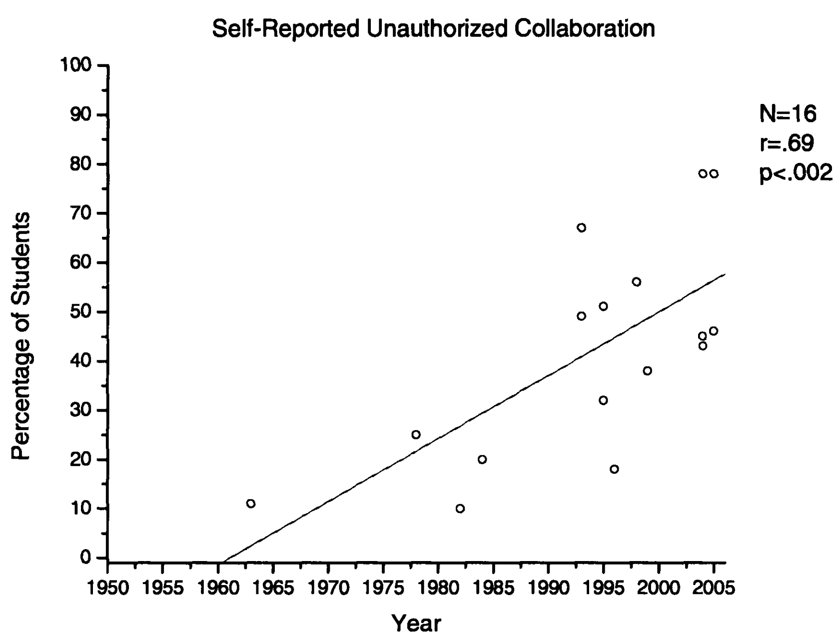

Figure 1-3: S-R Unauthorized Collaboration increases by ~3.5x over the period 1960-2005.

Summary and Discussion.

Although the 88 collected self-reported studies vary in time frames, school sample size, school characteristics, academic majors, etc., we believe when taken as a whole the data set is representative of what the average college "student" is reporting. To our knowledge, this is the first attempt at a comprehensive compilation of all available data reaching back fifty years.

Overall, the total data set suggests that S-R Cheating (General) has been increasing between 1955 and 2005. However, the result lacks robust significance because it is heavily contingent on one study - the Goldsen et al. study from 1954. Although we know no reason to formally discount Goldsen's results, the conclusion that any form of cheating is changing with time should not be affected by the removal of one study. A more valid, robust conclusion is that between the period 1965 and 2005 S-R Cheating (General) showed no statistically significant increase. The same argument applies to our treatment with regards to S-R Exam Cheating (Using Crib Notes). The robust conclusion is that there is no statistically significant decrease in S-R Exam Cheating (Using Crib Notes) between the period 1960 and 2005. The only forms of cheating that appear to be increasing with robust significance are S-R Unauthorized Collaboration and S-R Turned in Work by Another.

Many researchers have recently claimed that cheating is "epidemic" and increasing [7, 85]. Our study contradicts the claim that cheating in general is increasing. If cheating were increasing, we would expect to see several forms of cheating increasing over time. Only one form of cheating showed a significant increase; 5 of the 11 forms of cheating show no significant trends with time. More limited longitudinal studies might justify a statistically valid claim for systematic change within their narrow domain [23, 90]; however, in spite of the perspective afforded by the 50 year time period studied here, we cannot claim that, in general, cheating is increasing. Also, our conclusion that S-R Exam Cheating (General) has not significantly changed over the last fifty years is contrary to McCabe & Trevino's [90] findings that exam cheating has significantly increased from 39% to 64% of students polled in 1963 and in 1993. One reason may be attributed to the fact that McCabe and Trevino's longitudinal comparisons only included men at selective institutions.

Cheating Behavior	Mean	Standard Deviation	Std. Error of the Mean
Self-Reported Cheating (General)	56.7	25.0	3.5
Self-Reported Exam Cheating(General)	31.9	19.2	3.3
Self-Reported Exam Cheating (Copied From Another Student)	22.6	16.1	3.4
Self-Reported Exam Cheating (Helped Another student cheat)	27.6	16.2	3.3
Self-Reported Exam Cheating (Using Crib Notes)	17.3	9.1	1.9
Self-Reported Copied Material w/o Footnoting	38.5	14.2	3.8
Self-Reported Plagiarism	26.4	16.7	3.3
Self-Reported Plagiarism (Falsified a Bibliography)	26.1	12.8	3.6
Self-Reported Turned in Work by Another	10.3	5.0	1.1
Self-Reported Unauthorized Collaboration	37.4	20.7	5.2
Self-Reported Homework Cheating	44.2	19.2	4.1

Table 1-2: Mean, Standard Deviation, and Standard Error of the Mean for Each Cheating Behavior.

We do, however, support the claims that a very significant fraction have done each form of cheating at least once. Indicative of the current state of cheating is the mean, standard deviation and standard error of the mean for each cheating behavior (Table 1-2) The severity of the prevalence of each form of cheating depends on your definition for "epidemic." The minimum cheating reported in Table 1-2 was ~10% (Turned in Work by Another), and each of the other forms of cheating exceed 20%. The prevalence of each form of cheating should elicit concern among educators, not to mention a call for action, especially given the overall rate of S-R Cheating (General), S-R Exam Cheating (General), S-R Unauthorized Collaboration, and S-R Homework Cheating.

It is important to realize that these studies cover the entire college experience. The average student, who is ½ through his college coursework, has probably taken at least 30 exams, 50 quizzes, turned in 30 reports or papers, and over 100 weekly assignments. If cheating of various forms is not systematically repeated, then the fraction of students cheating on any particular exam or assignment could still be quite low.

It seems that any increase in S-R Cheating (General) can be attributed to the ~3.5x increase in Unauthorized Collaboration. With many classes emphasizing group work to foster social and communication skills, the line between authorized and unauthorized collaboration has lost focus, leaving some students confused about what constitutes illegal cooperation and what does not. Working closely with others means less time spent on the assignment, less headaches when stuck on a problem, and many students believe they learn more through the process, authorized or not [90]. Also, many businesses look for the ability to work well with others, so justification for this behavior comes easier to many students.

Surprising is the decline associated with the behavior of "Turned in Work Done by Another." Given the prominence of online paper mills and internet plagiarism, this is a behavior expected to sharply increase. More research should address this discrepancy to determine if the behavior is indeed decreasing. Quite possibly, students are increasingly underreporting the frequency of this behavior because it has received much scrutiny nationwide as more students turn to online paper mills for a quick, convenient fix to the term paper problem.

Conclusion.

We have attempted to summarize the extensive breadth of cheating research from 1955 in order to gain insight into the many forms of cheating, report an average prevalence for each form of cheating, and observe the temporal dynamics of each form of cheating. From our compilation of 88 self-reported surveys, we report that more than 56 +/- 3% of all students report that they have engaged in some form of cheating. Though the overall prevalence of self-reported cheating is disturbing, we do not find evidence that 10 of our 11 forms of cheating have increased since 1965; the exception being Unauthorized Collaboration. That reported levels of unauthorized collaboration have increased with time is not surprising given the renewed emphasis on group work and problem solving among peers; however, the conclusion that all other forms of cheating have *not* witnessed significant increases with time *is* surprising. In fact, our conclusion contradicts what many educators have previously asserted about the nature of student cheating post-1980.

1.2 Individual and Environmental Factors Associated With Academic Dishonesty

Given the prevalence of self-reported cheating, several pressing questions arise: Do some groups of students cheat more (or less), who is especially at risk, and what factors can we control to reduce cheating? Within the context of self-reported cheating, these questions are addressed by correlational studies, as researchers attempt to find factors that correlate with who will report cheating and who will not. In this section we summarize published data with regards to 10 individual factors and 9 environmental factors associated with cheating (Table 1-3 lists each individual factor, the number of studies contributing data, and the reference numbers as listed in the bibliography for each study; Table 1-4 lists each environmental factor, the number of studies contributing data, and the reference number for each study).

We consider individual factors to be factors associated with one person regardless of their social setting. Environmental factors are factors external to an individual that form the social construct around that person.

Individual Factor	N	Reference List
Sex	27	1, 9, 14(3), 20, 21, 26, 29, 32, 33, 43, 56, 65, 73, 75, 88, 90, 98, 101(2), 103, 111, 124, 125, 129
Morality	12	24, 34, 41, 45, 56, 79, 80, 84, 124, 128, 131, 138
Major	7	53, 99, 101, 103, 120, 122, 135
GPA	7	29, 32, 48, 53, 54, 117, 122
Cheating Norms	4	5, 47, 92, 97
Year in College	4	5, 44, 53, 99
Social Deviance	4	8, 9, 68, 104
Race	2	101, 129
Marital Status	2	23, 48
Task Orientation	2	103, 115

Table 1-3: Individual Factors Investigated

Environmental Factor	N	Reference List
School Size	40	1, 5, 12, 21, 23, 30, 44(10), 46, 48, 58, 65, 67, 69, 77(2), 78, 80, 86, 87, 92, 93, 97, 99, 103, 110, 122, 124, 135, 143, 148, 149
School Type	39	1, 5, 12, 21, 23, 30, 44(10), 46, 48, 58, 65, 67, 69, 77(2), 78, 80, 86, 93, 97, 99, 103, 110, 122, 124, 135, 137, 143, 148, 149
Honor Codes	8	14(3), 48, 86, 88, 90, 92
Testing Environment	6	17, 59-62, 64
Classroom Environment	6	2, 15, 58, 94, 110, 126
Fraternity Membership	5	44, 48, 53, 88, 91
Level of Education	5	5, 20, 68, 106, 120
Student Work Load	3	5, 45, 82
Grade Competition	1	5

Table 1-4: Situational Factors Investigated

Individual Factors Surrounding Cheating.

Gender. Studies that reported the percentage of the respective male and female populations that self-reported cheating were analyzed to find the overall correlation with gender. Two separate statistical measures were employed for analysis. First, the effect size between the two populations was calculated using Cohen's d statistic. The effect size between the male and female populations was +.2 standard deviations, meaning that males had a slight tendency to report more cheating than females. However, by Cohen's scale[16], this effect size is categorized as small. Whitley [146] conducted a gender meta-analysis with respect to cheating and also reported a small effect size with respect to the self-reported cheating of males vs. females. Figure 1-4 shows the results of each study with % males on the horizontal axis and % females on the vertical axis. Self-reported cheating gender differences are inconclusive. Further, this does not support conclusions about gender differences in actual cheating.

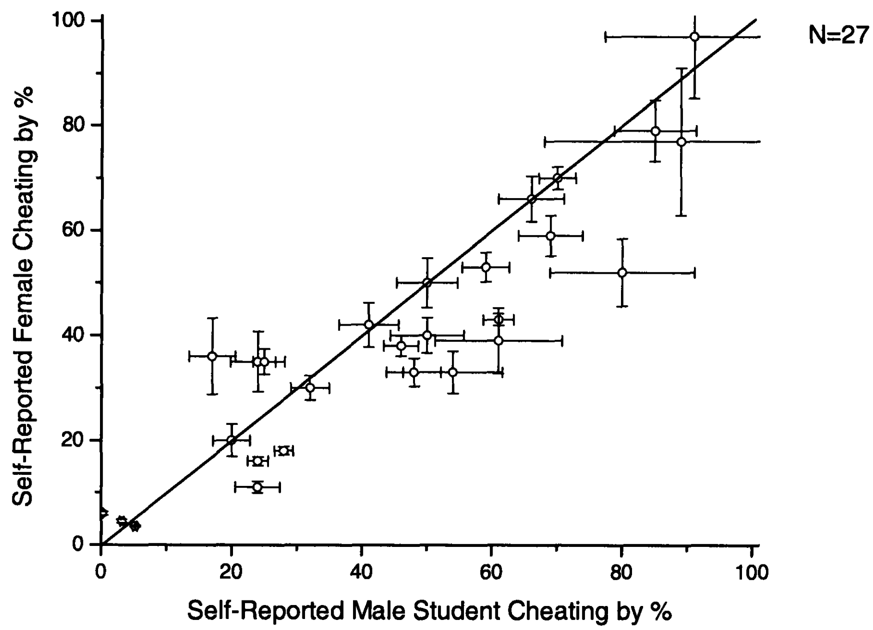

Figure 1-4: Male vs. Female S-R Cheating as reported in 27 studies. Points on or within error of the reference line indicate no statistical significance between the male and female populations. Of the 27 studies, 3 studies are above the line (indicating more females reported cheating), 12 studies are within the line, and 12 studies are right of the line (indicating more males reported cheating).Cohen's d statistic classifies this as a "small" effect.

Morality. No two studies presented data that could be combined as in our gender analysis. Some researchers have found evidence that as a student's moral development increases, their reported cheating behavior decreases [24, 56, 79, 84, 131]. Stevens [128] reported that morality was the most cited reason for not cheating, with 87% of students reporting they wouldn't cheat because of personal morals/beliefs. However, as many other studies point to the opposite conclusion. Forsyth [41], in two small experiments, concluded that cheating was not related to ethical ideologies. Other researchers have concluded the same [34, 45]. Vowell and Chin [138] reported that self-reported cheating increased with church attendance. The authors surmised that this phenomena may have more to do with the social characteristics of the students attending church, and not their religiosity. Smith [124] reported only small differences between a population of religious students and non-religious students, 57% of the non-religious students reported cheating and 52% of the religious students reported cheating. Leming [80] reported that 38% of students categorized as having "low" moral development reported cheating against 19% of students with "high" moral development. Morality and cheating may be intuitively linked, but no conclusive evidence supports this intuition.

Academic Major. 7 studies were located that directly investigated a specific major or made direct comparisons between majors. Using weighted averages, Figure 1-5 below shows statistically higher rates of reported cheating for business majors and engineers as compared to science and humanities majors. However, no statistical differences are evidenced between business majors and engineering majors.

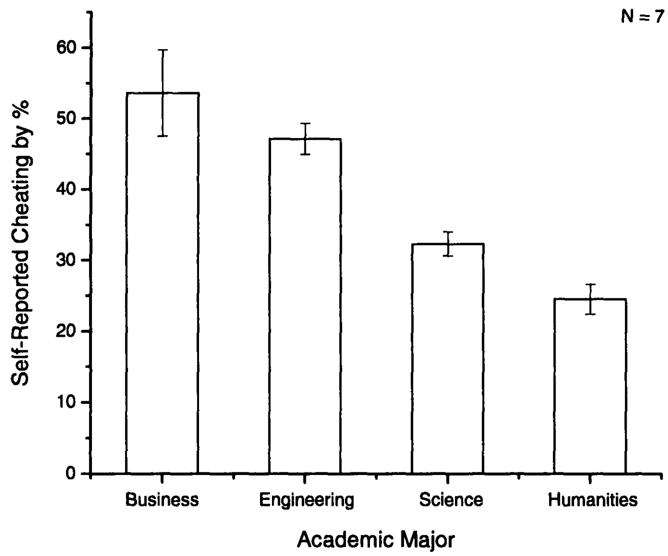

Figure 1-5: Academic Major vs. S-R Cheating as reported in 8 studies.

Academic Performance. Again, studies were used when they reported the percentage of the respective achievement group that self-reported cheating. Achievement was categorized into three subsets: Low (<2.5), Average (2.5-3.3) and High (>3.3). Figure 6 shows the results of each study with % Low GPA on the horizontal axis and % Medium GPA on the vertical axis. Figure 1-7 shows a comparison between students with Low GPA and High GPA. There is conclusive evidence that self-reported cheating correlates with low GPA.

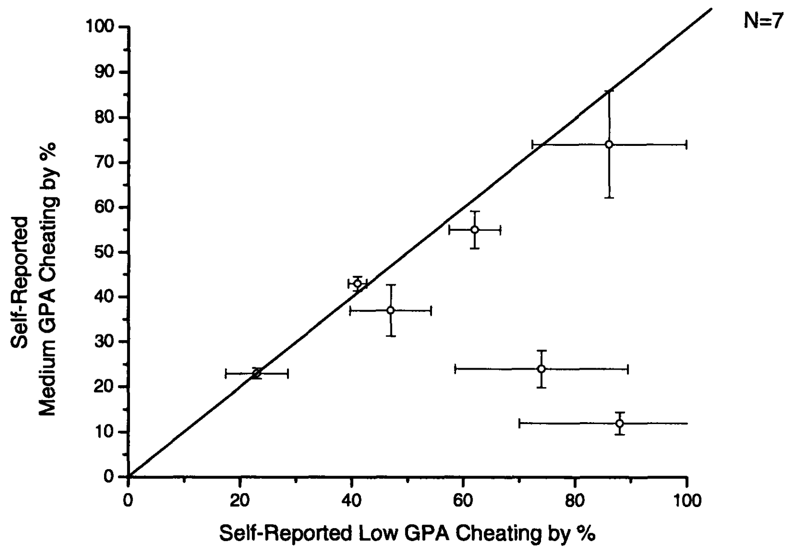

Figure 1-6: Low GPA vs. Medium GPA S-R Cheating as reported in 7 studies. Points below the reference line indicate more students with Low GPA reported cheating and points above the line indicate more students with Medium GPA reported cheating. 4 of the studies are left of the reference line and 3 of the studies are within error of the reference line.

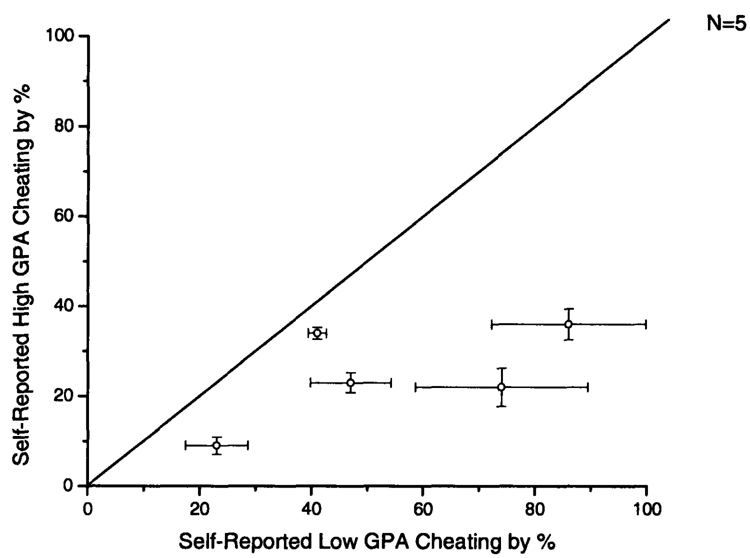

Figure 1-7: Low GPA vs. High GPA S-R Cheating as reported in 5 studies. All five of the studies are right of the reference line.

Cheating Norms. This individual factor relates how "normative" a student views cheating. In 1980, Baird reported that 40% of the students reported they felt cheating was a "normal" part of school [5]. Micheals and Miethe [97] reported that the frequency of a student's reported cheating increased as their peers reported cheating increased. They went on to say that with overall self-report rates above 50%, most students were guilty of cheating, thus establishing cheating as more normal than not cheating. McCabe reported similar results in 1997 [92]. In 2001, the number of students categorizing general cheating as normal grew to over 66% [47]. The research presents conclusive evidence that students are increasingly viewing cheating as "normal;" however, only one study links student's perceptions of cheating with actual cheating behaviors [97]. More research is needed that links the perception of students with their actual behaviors.

Year in College. Studies were used when they reported the percentage of the respective year that self-reported cheating. Also, two separate statistical measures were employed for analysis. First, the effect size between the four populations (Freshman vs. Sophomores, Freshman vs. Juniors, and Freshman vs. Seniors) was calculated using Cohen's d statistic. The effect size increased with each year of college, although even the greatest effect size, between Freshman and Seniors, is still categorized as small by Cohen's standard. See Figure 8 below. Figure 1-9 shows the results of each study with % Freshman on the horizontal axis and % Seniors on the vertical axis. Although initially the data point toward the fact that self-reported cheating differences exist between different classes, more data is needed. First, the overall effect size is still small. Second, the sample size (4 studies) is too small to make definite conclusions. Third, we do not know whether each study queried students for cheating over the previous year or over the entire college career. Depending on this subtlety, cheating could be either increasing with class or decreasing with class, therefore we cannot conclude that cheating is related to college class.

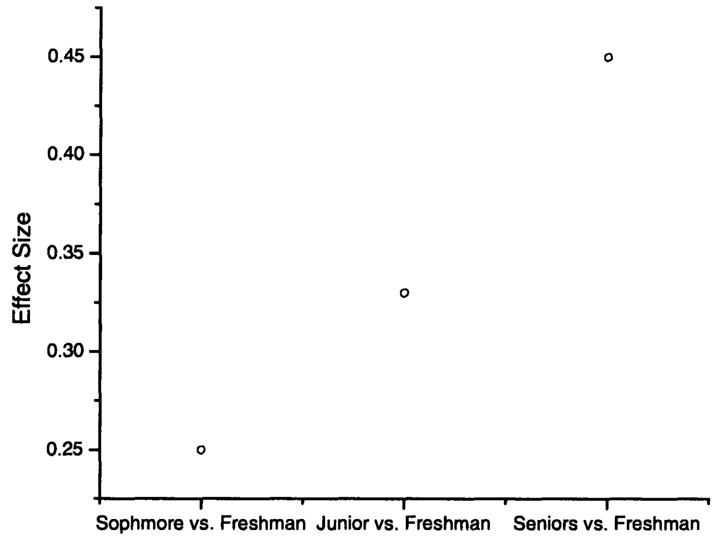

Figure 1-8: Effect Size vs. Year of College shows a "small" effect size between successive years in college.

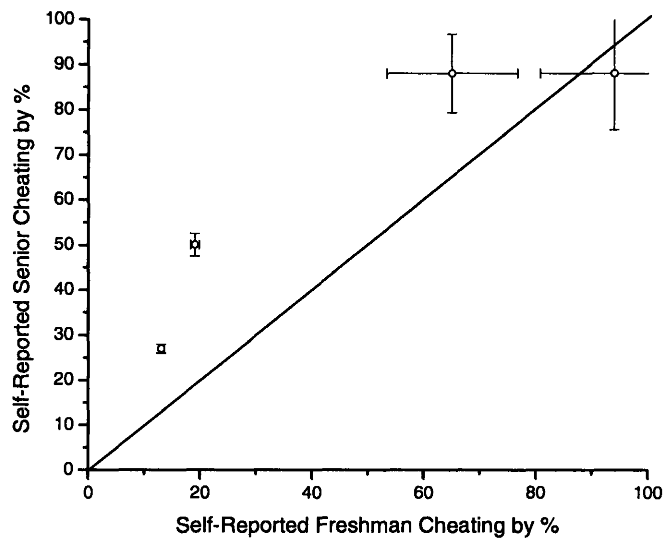

Figure 1-9: Year of College vs. S-R Cheating as reported in 4 studies. 3 studies are left of the reference line, indicating a statistical difference between Senior S-R Cheating and Freshman S-R Cheating. 1 study is within error of the reference line.

Social Deviance. Several authors have investigated the relationship between cheating and other forms of social deviance or crime, with the hypothesis that cheating is a form of social deviance. Beck [8] noted Pearson correlation coefficients above $r = .5$ ($p < .01$) for the relationship between cheating and two other forms of deviance: lying and stealing. Blankenship and Whitley [9] concluded that past cheating behavior is predictive of future deviant behavior. Nonis and Swift [104] found that business students who previously engaged in academic cheating behaviors were more likely to engage in workplace dishonesty. Jensen et al. [68] also reported that students who had lenient attitudes towards cheating were more tolerant of other forms of deviance. The presented data show conclusively that cheating is positively related to other forms of social deviance.

Race. Surprisingly, only two studies reported data related to race. Nathanson [101] reported cheating as detected on an assignment using plagiarism detection software. There was no difference reported for Caucasian and Black students, although there were slightly higher rates of Asian cheating detected as compared to other ethnic groups. Tang [129] also reported no difference between Caucasian and Black cheating rates. The data are incomplete regarding the relationship between race and self-reported cheating.

Marital Status. Only two studies have investigated the differences between cheaters with respect to marriage [23, 48]. Both studies report that married students report far lower rates of cheating than single students. Haines et al. [48] reported that 61% of single students reported cheating vs. only 25% of married students. More research is required to further validate this individual factor.

Task Orientation. While many studies focus on the demographics surrounding cheating students, few studies focus on the underlying motivations of these students. One motivation is task orientation-the internal goal of the student within a particular class or subject. Students may either be motivated to work hard in a class because they value the knowledge to be gained, while others are simply goal oriented-focusing on achieving a passing mark in order to graduate, meet scholarship demands, please parents, etc. Two studies mention and investigate this factor. Sandoe and Milliron [115] report that students who are motivated to learn the course material are less likely to cheat. Newstead et al. [103] reported that students classified as "stopgap," i.e. goal-oriented, reported cheating rates of 24% against students who were focused on personal learning reported cheating rates of 17%. Neither of these studies provide conclusive evidence, and this aspect of cheating deserves further inquiry.

Situational Factors Surrounding Academic Dishonesty.

School Size: Large vs. Small. We categorized school sizes into small (< 5,000) and large (> 5,000) based on their respective enrollments during the year of the study. Data was collected from 40 studies and is summarized using weighted averages in Figure 1-10. 73.4 % of students from large schools (16 studies) self-reported cheating compared with only 54% of students from small schools (24 studies). A bias may exist in this analysis because of the boom in college enrollment over the last 30 years. Studies that reported cheating rates from public schools considered large today, were measured as small for this analysis because in 1960 their enrollment was below 5,000. The data shows conclusively that more cheating is reported on large campuses vs. small campuses.

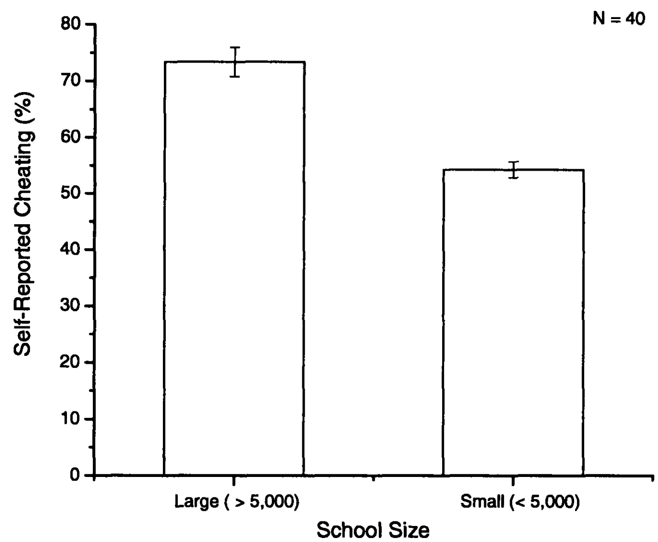

Figure 1-10: Size of School vs. S-R Cheating. Small schools self-report significantly less cheating than do large schools.

School Type: Public vs. Private. 39 Studies reported whether a school was public or private when disclosing data. Data were analyzed using a weighted average for both populations. Of the 39 studies, 31 reported data from public colleges and 8 reported data from private colleges. Studies reporting mixed data where the data could not be separated were not used. Figure 1-11 shows there is a significant difference between the self-reported cheating at public vs. private colleges. Two reasons could account for bias. One, the data were collected over a large time period, with the Goldsen et al. [44] study in 1960 reporting lower levels of cheating than all other studies after 1965. Two, students at private colleges may not report cheating as readily as students at public colleges. Because of these reasons, we conclude that more research specifically targeted on this subject is required.

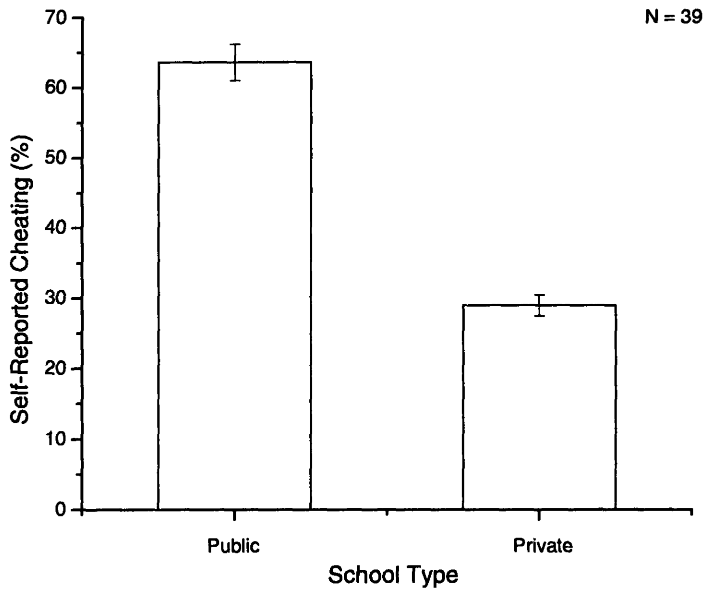

Figure 1-11: School Type vs. S-R Cheating. Public schools report more than twice the amount of cheating than private schools report.

Honor Codes. This factor is among the most often cited in the relevant literature. It is also the measure most often recommended for the reduction of cheating and perhaps the most misunderstood. McCabe [94] claims that the value of an honor code is understated; that honor codes play a significant role in the reduction of student cheating by fostering an environment of higher standards. Figure 1-12 below shows a statistical difference exists between the self-reported cheating at schools with honor codes and schools without honor codes. A study conducted by Hall and Kuh [50], that unfortunately did not include prevalence percentages, reported no statistical difference between cheating rates at three schools with honor codes and other schools without honor codes. The three schools with honor codes included a large, state school, a regional mid-size state school, and a small liberal arts school. Hall and Kuh attribute McCabe's results to very selective schools that contain other contextual factors that may explain the lower rates of self reported cheating-mainly schools founded on religious ideals. McCabe's study may have been influenced by the classic "Pygmalion" effect from social psychology: Students at honor code universities are expected to have higher ethical standards and lower rates of cheating; therefore, when confronted with the survey they feel obligated to report low rates of cheating regardless of the actual truth. The data are inconclusive that honor codes result in less reported cheating.

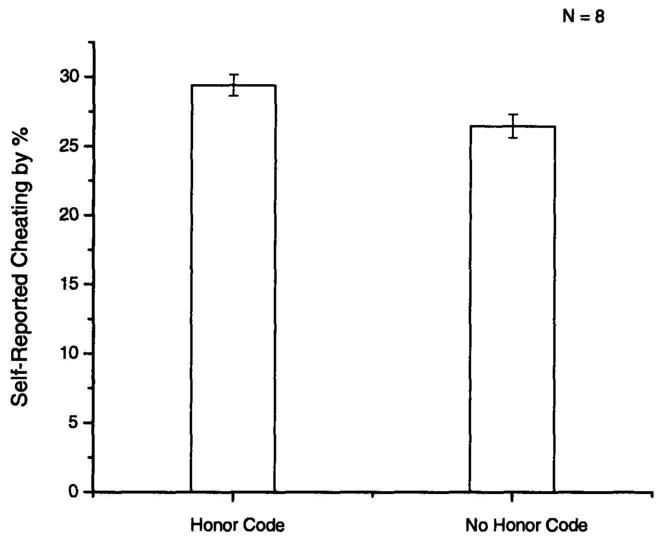

Figure 1-12: School Honor Codes vs. S-R Cheating as reported in 8 studies

Testing Environment. 6 studies were located that investigated the testing environment and its effect on cheating. Houston [59-62, 64] has shown that three major actions can help to reduce cheating during a multiple choice test:

-Assigned Seating
-Alternate Test Forms
-Sanctioned Threats

Houston has shown that spaced and assigned seating vs. unspaced and/or free seating can reduce cheating by ~30%. Using alternate test forms and sanctioned threats also helped to reduce cheating. Covey [17] has shown that close surveillance during tests can help to reduce cheating. The research presents conclusive evidence that the testing environment can influence student cheating.

Classroom Environment. 6 studies were located that addressed the topic of the classroom environment, specifically class size and class type. Pulvers et al. [110] reported that students who reported cheating viewed their classes as less personal. McCabe [94] reported that larger classes showed a small but significant correlation with higher levels of reported cheating. Hollinger [15] reported that 70% of students polled said that smaller classes could reduce cheating. Steininger [126] reported that among students top 4 reasons to not engage in cheating were meaningful tests, interesting classes, and quality professors. Finally, Ahmed [2] reported that students were less likely to cheat as student-teacher familiarity increased. Taken as a whole, the research presented here indicates that smaller classes with more individualized attention and increased student professor interaction can impact reported rates of cheating.

Fraternity/Sorority Membership. 5 studies were located that directly compared fraternity membership and cheating prevalence. Fraternity members report an average of ~20 +/- 5% more cheating than non-members (Figure 1-13). The data are conclusive that fraternity members report more cheating than non-members.

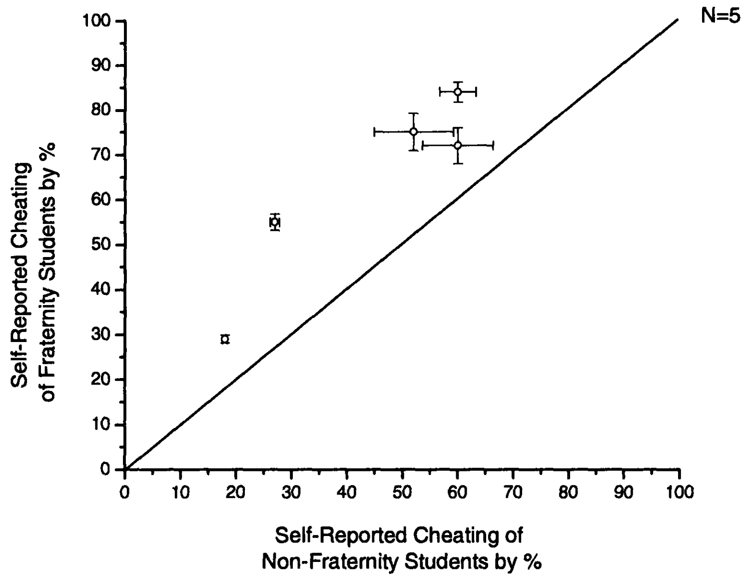

Figure 1-13: Fraternity Membership vs. S-R Cheating as reported in 5 studies. All 5 studies are to the left of the reference line, indicating a statistically significant difference between the reported cheating of fraternity members and non-members.

Level of Education: High School vs. College. 5 studies were located that directly queried each student for both high school cheating prevalence and collegiate cheating prevalence. Figure 1-14 below shows a statistical difference between high school cheating and collegiate cheating. The data are conclusive that college students report that they cheated more in high school than in college.

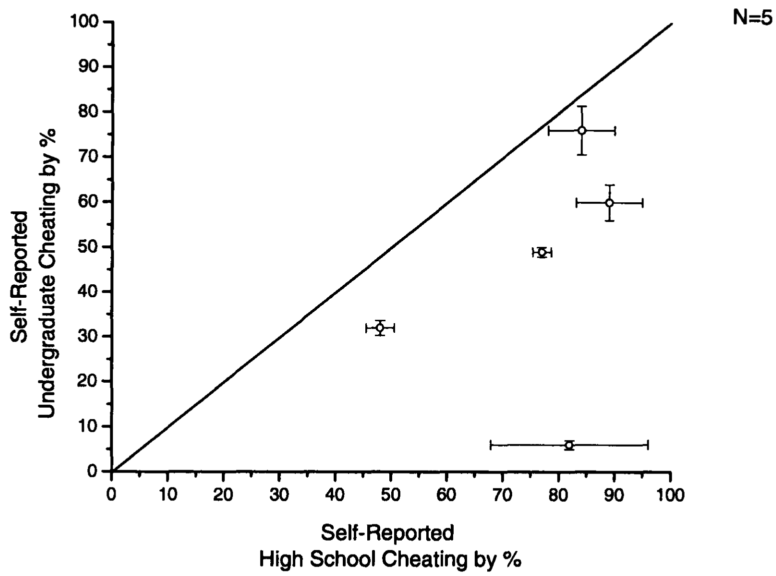

Figure 1-14: High School vs. Collegiate S-R Cheating as reported in 5 studies. All 5 studies are to the right of the line, indicating a statistically significant difference between S-R Cheating in High School and College.

Student Workload. Three studies reported data related to students perceived workload and their cheating motivations. Baird [5] reported that 26% of students (N= 200) indicated that heavy academic workloads were the reasons they cheated. Graham [45] reported that 60% of students listed heavy academic workloads as the reason behind their cheating. Lipson and McGavern [82] reported the top three reasons behind student cheating were overly time-consuming assignments, overly difficult assignments, and multiple assignments due on the same day. All of these three reasons are directly linked with student workload. Although the presented research indicates a positive correlation between student workload and cheating, more research is required to further validate and quantify this environmental factor.

Grade Competition. Although many studies [45, 103] attribute grades as the principle reason behind student cheating, only one study investigated the phenomena of grade competition. Baird [5] reported that 35% of students (N=200) listed grade competition as the principal reason behind their cheating, the most of any listed reason. More research is required to further validate this environmental factor.

Summary and Discussion.

Results of our conclusions concerning the relationship between the reviewed factors and cheating are summarized in Tables 1-5 and 1-6. Of the individual and situational factors investigated, 9 factors presented an incomplete picture due to insufficient study sample size or existing biases. These factors include Cheating Norms, Year in College, Race, Marital Status, Task Orientation, School Type, School Size, Student Workload, and Grade Competition. For each of these factors, further research is recommended to determine whether an effect on cheating behavior does or does not exist. Significant supporting data exists for 4 factors: Sex, Morality, Academic Major, and Honor Codes; however, for each of these factors published data present conflicting results, therefore we also consider the relationship between these factors and cheating as inconclusive. We observe significant, results for the relationship between the remaining factors and cheating. These 6 factors are GPA, Social Deviance, Testing Environment, Classroom Environment, Fraternity/Sorority Membership, and Level of Education.

Individual Factor	N	Conclusion
Sex	27	Inconclusive (Conflicting Results)
Morality	12	Inconclusive (Conflicting Results)
Major	7	Inconclusive (Conflicting Results)
GPA (High vs. Low)	7	Conclusive (Low GPA → More Cheating)
Cheating Norms	4	Inconclusive (Sample Size)
Year in College	4	Inconclusive (Sample Size)
Social Deviance	4	Conclusive (Deviance → More Cheating)
Race	2	Inconclusive (Sample Size)
Marital Status	2	Inconclusive (Sample Size)
Task Orientation	2	Inconclusive (Sample Size)

Table 1-5: Summary of individual factors and cheating

Environmental Factor	N	Conclusion
School Size	40	Inconclusive (Sample Bias)
School Type	39	Inconclusive (Sample Bias)
Honor Codes	8	Inconclusive (Conflicting Results)
Testing Environment	6	Conclusive (Constrained Environment → Less Cheating)
Classroom Environment	6	Conclusive (More Teacher/Student Interaction → Less Cheating)
Fraternity Membership	5	Conclusive (Frat. Members → More Cheating)
Level of Education (HS vs. College)	5	Conclusive (High School → More Cheating)
Student Work Load	3	Inconclusive (Sample Size)
Grade Competition	1	Inconclusive (Sample Size)

Table 1-6: Summary of situational factors and cheating

Conclusions.

We have summarized the results of over 80 unique studies into the relationship between various individual and situational factors and the amount of reported student cheating. From 19 factors, we conclude that only 6 have significant relationships toward the cheating behavior of the representative groups of students. From these 6 factors, it is noteworthy that only 2 are individual factors and that most of the significant factors were based on the student's social setting. Thus, it seems that among many possible factors, the most pertinent are the environmental factors that surround a student, and not the individual characteristics of that student. This may be too simplistic, and in individual schools and classes individual factors may outweigh social factors. However, our review of these factors should stimulate further thought, and hopefully motivate researchers to examine as to why the social setting of a student seems to have a more concrete relationship with cheating than that of the student's individual characteristics.

1.3 Psychological and Social Ideas Forwarded to Explain Cheating

Cheating requires a conscious decision followed by some action; moreover it occurs within a social context. Therefore, both psychologists and sociologists can and do have theories, many backed by experimental evidence, that explain why students cheat and offer perspectives on how cheating behaviors can be reduced.

Why do students cheat? The simplest reason is for personal gain: to improve grades and future rewards based on grades [137], to avoid the penalties of bad grades (such as loss of scholarship, public embarrassment, etc), or simply to save time. Other factors influencing a student's choice to engage in a cheating behavior are dissatisfaction with the classroom environment and coursework motivations (i.e. viewing the course outcome in task-orientation vs. a goal-orientation framework).

In an effort to understand student motivations for cheating, researchers have forwarded several social and psychological theories. Only through an understanding of what drives students to cheat can educators enact a program aimed at the reduction of cheating. Researchers have forwarded and tested two primary social theories: Social Control Theory and Social Learning Theory. Psychologists have proposed several models to explain cheating including the Deterrence Model, the Rational Choice Model, the Neutralization Model, and the Self Control Theory. Each psychological model proposed by psychologists can be tied to one or both social theories. A brief description and summary of results supporting or negating each social theory and psychological model is presented.

Social control theory. Also known as Social Bond Theory [97]. Social Control Theory states that individuals form a series of four bonds with society. These bonds are Attachment, Commitment, Involvement, and Belief [97]. "Attachment" refers to the relationships with parents, peers, and other surrounding honest individuals who insulate a person from crime. "Commitment" refers to the investment of personal interests in normal activities. "Involvement" refers to the level of participation in conventional activities. Accepting the laws, moral beliefs, and norms of our society represents "Belief". Students are only able to cheat once one or more of the social "bonds" are broken [31].

Micheals and Miethe's [97] results support two of the four social bonds: attachment and belief. They measured an increase of individual cheating behaviors as students reported that more of their peers were also cheaters. Students who viewed cheating as a serious, harmful behavior were less likely to report cheating. However, cheating frequency was not correlated with religious or moral beliefs. The authors noted no correlations with cheating behavior for the social bonds commitment or involvement. In their results, social bond theory accounted for 10% more variance than using the control variables alone.

Social Learning Theory. Also known as the Culture Conflict Theory [31] and derived from Sutherland's differential association theory [83]. In Social Learning Theory, students who cheat belong to a social group which differs from a "control" social group. This smaller, deviant group holds norms and values at odds with most of society [31]. Students develop a culture of cheating norms and values over time as they interact with other students within the deviant social group [97]. When a student is closely associated with a group whose norms include cheating, then that student is more likely to cheat and to view cheating as acceptable. Conversely, if a student's peers view cheating negatively, then their own cheating behavior is likely to be reduced.

Micheals and Miethe [97] report that Social Learning Theory accounted for 4% more variance than the control variables sex, age, class, etc. Social Learning Theory also accounted for future cheating behaviors better than other models. Vowell et al [138] remark that Micheals and Miethe's above results concerning Social Bond Theory are misplaced and could support either Social Learning Theory or Social Bond Theory. The results presented by Micheals and Miethe do not distinguish whether the bond of attachment formed by cheating students is internal or external to a separate group consisting of skewed values.

Deterrence. The Deterrence Model of cheating states that by invoking punishment educators can deter students from cheating behaviors. Punishments ranged from course failure to expulsion. Haines et al. [48] show that the greater the utility of the act, the greater the punishment required to deter the act, in accord with general deterrence theory. Tittle and Rowe [147] acknowledge that deterrence can reduce cheating; however, some students indicated they would continue cheating no matter the consequences. When Tittle and Rowe compared the act of a sanctioned threat against a moral appeal to stop cheating, they found that the moral appeal had no effect whereas the threat significantly reduced cheating. Tittle and Rowe also noted that students in the lowest stratum of class grades had the lowest response rate to the threat. Micheals and Miethe also showed that deterrence can reduce cheating, although they could not show that deterrence explained much of the variance (only 1%) of cheating behaviors when compared to the control variables such as age and sex.

Rational Choice Model. - Similar to the Deterrence Model; however, the Rational Choice Model also takes into account the rewards to be gained from cheating as well as the possible punishments [97]. If a student sees the potential gains of cheating outweigh the risks, then he/she is more likely to engage in cheating. Micheals and Miethe showed that the Rational Choice Model explained 6% more variance than the control variables and that cheating increased as the cheating reward outweighed the cheating risk.

Neutralization. Neutralization is the act of rationalizing a cheating behavior as justified even though the student knows internally it is wrong. [48]. Students make use of this technique before, during, and/or after the act of cheating. Five specific types of neutralization exist: denial of responsibility, denial of the victim, denial of injury, condemnation of the condemners, and appeal to higher loyalties. Vowell [138] noted that the act of neutralization by a student is just an extension of social learning theory. Liska [83] and Haines et al. [48] both focused on the role of neutralization in describing the cheating behavior.

Liska [83] linked the Neutralization Model to Social Control Theory when he noted that only in situations absent of social control does the concept of neutralization play a significant role. Haines et al. [48] showed a significant difference between cheaters and non-cheaters levels of neutralization using an 11 item test that exposed the students to situations relevant to all five types of neutralization. Further, Haines et al. demonstrated links between neutralization and deterrence because students with the greatest tendency to neutralize were most influenced by traditional deterrence methods (receiving a failing grade or being dropped from the course) and least deterred by their own guilt or the disapproval of friends.

1.4 Methods of Cheating Detection

Literature associated with the detection of cheating students is restricted to two realms: cheating on multiple choice exams and plagiarism of written course work. We investigate each situation and summarize current methods available to educators. Despite using disparate statistics, each method compares answer similarity against all other exams or papers submitted. Finally, we discuss the underutilization of detection methods in the classroom.

The importance of standardized multiple choice tests, such as the SAT or the ACT, has raised the reward for such cheating; advocates of the Rational Choice Model would claim that students are more likely to cheat on these tests as the stakes increase. Many college courses still rely on single-form multiple choice exams, despite the relative ease with which students can cheat on these tests.

Detection of cheating on multiple choice exams.

Detection of answer similarity on multiple choice tests is not a nascent field; first studies were published over 80 years ago, though most work was initiated after 1970 [144]. The ACT (formerly known as American College Testing) has conducted at least one major research project aimed at detecting students cheating on their standardized tests [51]. Harp and Hogan [52], Rizzuto [152], Wesolowsky [144], and most recently Jacob and Levitt [66] also investigated methods of detecting cheating on multiple choice tests. Each of these methods, although employing differing statistics, relies on the detection of answer similarity between pairs of suspected exams.

Harp and Hogan [52] began investigating possible cheating on their multiple choice chemistry exams when a student reported two other students for cheating. Upon inspection of the two reported students, Harp and Hogan [52] found 97 of 98 identical answers! This included 27 wrong answers marked similarly for both students. They developed a computer program that compares pairs of student answer sheets and looks for a high ratio (>.75) of exact errors in common, i.e. exact wrongs (EEIC), to errors in common (EIC). Their cutoff was arbitrary in that they found no pairs of adjacent students with an index lower than .75. They reported finding 5 pairs of students with ratios between .79 and 1.0. After inspection of the seating chart, each student in the pair had sat adjacent during the exam.

Wesolowsky [144] used a similar statistical method with comparable results. He assigned probabilities to each students answer based on the ability of the student and the difficulty of the question and then compared similar answer sets. The distribution of answer similarity between pairs of students should approximate a Gaussian distribution. Cheating students with a high percentage of identical answers are revealed in the tail of the distribution. This allows the assignment of a p-value to the probability that the pair of students with similar answers is due to a Type I error. When the identification of student pairs was checked against seating charts recorded during the exam, each pair was seated in adjacent desks.

Perhaps the most widely known case study was detailed in the popular book Freakanomics [151]. The authors, a pair of economists, applied their knowledge of statistics to the annual comprehension exams given to third graders in the Chicago Public School System, with one caveat: their aim was to detect *teachers* cheating, not students. Levitt and Jacob used two classes of indicators to detect teacher cheating, with a final arbitrary cutoff above which he considered a class to have a cheating teacher. They focused on two primary statistical indicators: Unexpected test score fluctuations between successive years and similar answer strings within the class.

Unexpected Test Score Fluctuations. Classrooms with a cheating teacher will experience unexpectedly large gains in test scores relative to those same students' scores the year before. These large test score gains should be systematically followed by large test score declines the following year because the original gains were not due to any knowledge the student genuinely learned. A classroom SCORE is computed using the rank within all other classes of the first year gain squared, plus 1 minus the rank of gain the following year squared.

$$\text{SCORE} = (\text{rank\_gain}_y)^2 + (1\text{-rank\_gain}_{y+1})^2$$

Suspicious answer strings. Classrooms with a cheating teacher will exhibit unusual strings of answers. Levitt and Jacob characterize these patterns into the following categories:

a.) Blocks of Identical Answers

b.) Unusual patterns of correlations across student answers within a class

c.) Unusual response patterns within a student's answers (i.e. a student answers "hard" questions right and "easy" questions wrong)

After the identification of more than 100 possible cheating teachers, retests were administered to 137 classes-each of the suspected classroom plus an additional 41 classrooms to be used as a control group. Levitt and Jacob hypothesized that true knowledge would manifest through the retest while cheating classrooms would not sustain reported knowledge gains. The retests were proctored by outside sources and teachers were not allowed to interact with their classroom during the exams or see the exam prior to the retest. The results were dramatic: Almost every classroom suspected of cheating saw significant score declines, while the classrooms not suspected retained similar scores.

The cumulative lessons from these case studies include:

- Students cheating on multiple choice tests will have a high degree of answer similarity
- Students will have strings of similar answers, including right and wrong answers
- Students will do better than expected (from their overall score) on difficult problems
- Students will do worse than expected (from their overall score) on easy problems

Because each of these methods is slightly different, and can't be universally applied with only one measurement, the detection of cheating is best served by employing several methods concurrently and deciding which method is most relevant to the particular case at hand [51].

Detection of Plagiarism.

Electronic word processors and the internet have greatly extended the power of an old cheating modus operandi: Plagiarism of written work and term papers. Three decades ago, plagiarism of a friend's (or one's own) term paper required at least typing the whole paper. Magnetic recording media and the internet have reduced this to a two minute operation. Even two decades ago, purchasing a prewritten term paper required the student to undertake a series of actions: Write the term paper company, find the desired paper, send payment to the term paper company, etc [57]. The internet has reduced this sequence into a 10 minute process that is not only effective, but fast and convenient as well. Billed as the first internet paper mill, schoolsucks.com opened in 1996 with just 20 papers. Today, schoolsucks.com boasts over 50,000 papers. In 1996, its founder touted that the site's free access would drive other paper mill towards bankruptcy. Ten years later, the pay-for-paper business is bigger than ever, with hundreds found through any search engine. "Evil House of Cheat" boasts over 4,000 visitors each day [47]. The explosion of the term paper business necessitates electronic countermeasures that can balance electronic plagiarism.

A countermeasure against "sharing" term papers materialized in the form of a program called CopyFind, developed by Louis Bloomfield at the University of Virginia in 2000. The physics professor received a tip that several students had submitted identical term papers in his introductory physics class. He subsequently wrote a program that searches for strings of consecutive words, at least six in this case, and detected 60 students guilty of plagiarism out of ~400 students [118]. Applying the program to a past class detected an additional 62 students guilty of plagiarism. His program has been applied at other schools as well-including the University of California Santa Barbara [70]. Today, the educational market boasts several species of program that can be used to identify plagiarizing students. WORDCheck is available for institutions at a price between 100$ and 1000$. Turnitin.com, Eve2, Paperbin, and CopyFind2.1 are other examples of programs that pattern match words and phrases to detect plagiarism. CopyFind2.1 is a freeware update of the original CopyFind.

Essentially, these computer programs function by assigning a digital "fingerprint" that uniquely identifies each document. The fingerprint is calculated using complicated custom algorithms. Then the submitted document is cross-referenced against all other "fingerprints" in the database. Turnitin.com, for instance, also has access to online sources such as ProQuest and other academic databases, allowing a document to be matched against literally millions of published documents [107]. This process takes only a few seconds, including output of the results.

The next frontier of cheating detection is the combination of multiple choice exams and electronic plagiarism: the web-based, online distance education class. In 2000, Sandoe and

Milliron [115] noticed irregularities within the online quiz submissions for a management information systems class. Using data such as student ID, timestamp of quiz submission, IP address, etc. the instructors searched for student collaboration on quiz answers. First, they isolated all student pairs indicating a high ratio of answer similarity. Then a significance level was approximated for each pair using a cumulative binomial distribution. Of the 68 students implicated (23% of the class), 24 immediately confessed. The remaining 44 refused to cooperate or denied involvement. Of the 44, 29 were implicated within a pair, or group, of students where another had already confessed. The authors note that students not only shared answers with each other, but students also worked together simultaneously. Several students exploited technical problems within the program itself, including password theft, programming the quiz to allow more time, and programming the quiz to select only certain questions for certain students [115].

Why are so few detected cheating?

With just the methods outlined above, a multi-tooled arsenal is available to teachers. Why, then, do so many students report cheating, and so few report being caught cheating? Despite the successes of the case studies listed above, most teachers seem to ignore the issue. In short, methods developed to identify cheating students remain underutilized in the classroom. First, faculty consistently report they believe cheating to be much less of a problem than students do. Second, most teachers avoid prosecution of suspected cheaters for fear of the hassle of protracted legal battles and the eventual acquittal of the students by discipline committees. The rejection of detection methods on grounds rooted in the unwillingness to charge individual students means that a more important measure, namely the estimation of cheating across an entire class, is lost [144]. Students, however, are not lost on their teacher's inaction: The book Cheating 101: The Benefits and Fundamentals of Earning an Easy A [153] openly mocks teachers for allowing the continued cheating by students who capitalize on the "see no evil, hear no evil" attitude embodied by many teachers.

1.5 Literature Review of Cheating Remediation

In this section, we will summarize previous experimental work and ideas regarding cheating remediation as well summarize the effectiveness of several factors towards the reduction of student cheating. The literature that has focused on cheating remediation is scant: Only two authors have published studies that report the results of experimental efforts to reduce the prevalence of student cheating. Although several other authors have forwarded ideas that might help reduce cheating, few remediation ideas are ever operationalized operationalized into a project or experiment that measures cheating before and after, presenting conclusions that quantify the effectiveness of the remediation scheme. We will review both experimental results and miscellaneous remediation ideas.

Houston has conducted several experiments designed to measure and reduce test cheating during multiple choice exams [59-63]. Houston measured test cheating using an index of wrong answer similarity, not unlike the Harp-Hogan index reported several years later [52]. His remediation efforts included using additional proctors, multiple forms of the same test, seating charts, and spaced seating between students. Of these, using additional proctors and spaced seating were effective at reducing test cheating. Alternate test forms and/or seating charts did not measurably reduce cheating.

The only other known experimental approach to cheating remediation was conducted by Canning [14] between 1948 and 1953. Over six subsequent psychology classes, cheating on a multiple choice test was measured by letting the students self-grade their own tests. Using pre-duplicated copies of each test, the fraction of students that cheated during the self-grading process was measured for each class. The year prior to the honor code implementation, 81% of the students were detected cheating. In years subsequent to the implementation of the honor code, the weighted average of the fraction of students who were detected cheating was .38.

Other authors have put forward ideas concerning remediation. Tittle and Rowe [147] stated that proper levels of deterrence could curb cheating. If students understand that harsh penalties will be assessed for detected cheating, and they believe they will be caught, then cheating could be reduced. Stern and Havlicek [127] put forward that smaller classes and an increased proctor:student ratio during tests could reduce test cheating.

A unique study by Faulkender et al. [33] provides important perspective on the persistent nature of cheating and the difficulty of remediation. Faulkender et al. published results detailing the events and follow-up actions surrounding a stolen psychology mid-term examination. From a psychology class of ~300 students, 40% of the students admitted to illegally obtaining a copy of the test. Test results were voided, a retake was scheduled, mandatory ethical discussions were held by TA's, and a follow-up attitudinal survey was conducted. Over 80% of the students that had a copy of the original test reported through the survey that they would repeat their actions if given another opportunity to obtain copies of a stolen test.

Summary and Discussion.

Why isn't cheating remediation research more robust? Perhaps it is because few correlates of cheating have been convincingly established. In section 1.2 we claimed that of 19 cheating correlates based on individual and situational factors 13 were not significant factors or required further research . Without a thorough understanding of how and why students cheat, any plan to reduce cheating remains mostly guesswork. Further, a successful remediation plan must include the use of tools that can accurately detect and measure cheating. Most cheating studies rely on the self-reported (S-R) survey, and while many researchers claim that SR cheating survey data are reliable, other authors have presented contrary evidence [29]. In summarizing the results of our own S-R cheating survey, we also present evidence that furthers our argument that S-R cheating survey data are not as reliable as many researchers contend (see Chapter 3.3).

Each of the studies and ideas reported here concern only test cheating. While the reduction of test cheating is certainly a worthwhile pursuit, we should remember that it is often the least reported form of cheating. Despite our concerns about the accuracy of S-R cheating data, we concede that SR studies are probably correct in that test cheating is among the least prevalent forms of cheating. Equally, if not more worthwhile, would be to study the reduction of the most prevalent forms of cheating: unauthorized collaboration and/or homework cheating.

Conclusions.

We have summarized published research with respect to the remediation of cheating, including the application of factors such as honor codes, ethical discussions with students, alternate test forms, spaced seating during tests, and seating charts during tests. With respect to each of these factors and techniques, we believe that further research is warranted because of the paucity of significant, robust results. Further, we believe that to obtain significant results from a cheating remediation study, the cheating must be accurately detected and measured, both before and after remediation, and the cheating correlates more fully understood.

Suggestions for Future Studies

The moralistic ("did you ever cheat?"), rather than quantitative (what percentage of final exam questions did you copy?"), nature of most cheating surveys detracts significantly from their value, in our opinion. From the viewpoint of a classroom teacher or a Dean, the issue of cheating is (aside from the moral issues) one of degree or severity. If a few students use crib sheets to raise their grades from C+ to B-, most teachers will not revamp the whole administrative structure for administering exams. But we hope this would not be their reaction to finding that 20% of their students learned little in their course but passed by copying verbatim the entire final exam of the student next to them. Most surveys in our data base could not distinguish between these extremes even if they occurred in a majority of college courses; moreover, the results of the poll under either set of circumstances could be consistent with the average results reported from these surveys. We would strongly recommend that future surveys ask more quantitative questions such as:

> What percentage of the papers you have turned in have been completely your own work?
>
> On what percentage of the questions on your math and science homework did you submit solutions that you copied from another source?

Also, it would be wise to assess the students' opinion of whether copying of tests significantly raised their grade or whether copying of homework materially reduced what they learned.

Another topic for future research would be to try to discriminate between the various psychological and sociological theories: do poorer students with scholarships cheat more (e.g. out of fear that they will lose the scholarship)? Do good upper classmen cheat more than bad upperclassmen (e.g. to raise their grades for admission to graduate school)? Do students taking more courses, therefore placing themselves under greater time pressure, cheat more? Is assignment cheating a conscious decision made well in advance or does the student maneuver into a situation where cheating is their only recourse?

Finally, we really encourage more attempts to measure actual cheating rather than continuing to rely on self-reported cheating. Ideally these should be compared with simultaneous self-reported surveys. Without this, we cannot be sure that self-reported cheating demographics reflect reporting bias or differences in actual cheating. For example, having an honor code creates a climate in which cheating is more objectionable morally and may lead to under-reporting, whereas it creates an environment that facilitates and might therefore encourage actual exam cheating. Even the robust conclusion that men report about 10% more cheating than women may be a reporting artifact - after all gender-bias is so evident in self-reported sexual surveys that frequently conclude "men claimed to have had considerably more partners than women" [154] that there are many papers devoted to the sources of this discrepancy [see L.A. Wittrock UW-L Journal of undergraduate Research VII (2004) and references therein].

2 Patterns and Consequences of Copying Web-Based Physics Homework

This chapter presents the most significant work in this thesis – the direct detection and study of homework copying. This direct detection gives our study two distinct advantages over self-reported surveys. Firstly, we can study copying minute by minute, day by day, and over the course of the semester, revealing patterns of copying that would be impossible to determine with a S-R survey. Secondly, since it is not anonymous, we can study the academic consequences of copying homework. These factors allow our study to reveal patterns not even suggested before. In addition, we show a strong link between copying and declining academic performance that is strong enough to call into question the general belief that cheating on examinations is more serious than cheating on homework.

An algorithm that detects electronic homework copying was applied to three successive Newtonian Mechanics classes at MIT: Fall 2003, Fall 2004, and Fall 2005. An electronic log of all interactions the student makes with the homework system, including start time, finish time, correct answers, wrong answers, and hints requested allows the algorithm to assign a "copying" probability to each problem completed.

The performance and behavioral patterns of students who copy a lot and students who copy a little is compared and contrasted. Because of a small sample size, data from the Fall 2004 class was not included in the patterns and consequences analysis presented in this chapter, but will be included in a future remediation analysis. Also analyzed are several demographic variables are their relation to homework copying, including gender, age, ethnicity, math skill, and previous physics experience.

We also present two prediction algorithms. The first is designed to predict a student's 8.01 final exam performance with only 30% of the course completed, thus allowing instructors to identify early-term who is at risk of poor performance on the 8.01 final exam. The second prediction algorithm utilizes select variables from a student's 8.01 performance in order to predict their performance in 8.02. This algorithm can identify student's who may have passed 8.01, but are still at risk of subsequent poor performance in 8.02.

2.1 Fall 2003 Patterns and Consequences of Web-Based Physics HW Copying

Abstract

Students copying answers to their web-based electronic homework was directly detected in the Fall 2003 Newtonian Mechanics class at MIT (N=428). Homework copying is detected using a detection algorithm which assigns a "copying" probability to each student-problem by analyzing all student interactions with the homework server, including start time and end time, wrong answers, solutions, and hints requested. Repetitive homework copying (copying over 30% of all answers) presages steeply declining exam performance over the term. The correlation of copying with the final exam implies that copying all homework would lower final exam performance by 2 standard deviations. 31% of all repetitive homework copiers (N=72) failed to complete the required two semester physics sequence on schedule, an attrition rate ~ 4 times that of students who don't repetitively copy homework, even though the two groups were separated by only 0.2 +-0.2 standard deviations on the initial diagnostic test given on the first day of class. Repetitive copiers copy much more of the problems on assignments later in the term, and are more likely to copy problems that are difficult or appear late in the assignment. They also do fewer not-for-credit exam preparation problems. Homework copying accounts for the largest variance among several variables in predicting student success on the Newtonian Mechanics final exam. Our results suggest that stopping homework copying would reduce the attrition rate in the first year required physics course sequence by about ½.

Students often cheat on their academic work, a practice that is neither nascent nor declining [9]. Between 1955 and 2005, over 100 studies involving self-reported rates of student cheating have been published [9]. Most research separates academic dishonesty into four major categories: General cheating, exam cheating, plagiarism, and unauthorized collaboration. Of these four types of academic dishonesty, the actual detection of student cheating has been limited to exam cheating and term-paper plagiarism [1, 2, 7]. It is no coincidence that faculty and students routinely rate these two forms of cheating as the most serious [3,4]. Unauthorized cooperation, which includes homework copying, is considered less serious by students and faculty alike and receives far less attention, although an average of 44 % of students self-report multiple instances of copying of homework assignments [9].

In this study we directly detect instances of homework copying throughout an entire semester. We show marked differences between students who copy a lot and those who copy little, if at all, in how they allot their time and when they do their homework. We find that homework copying is the most significant early warning factor in predicting student performance on the final examination.

Our study was conducted in the required introductory Newtonian Mechanics class (N=428) at MIT during the Fall of 2003. Data were obtained from a web-based homework tutor, MasteringPhysics (www.MasteringPhysics.com) which records every interaction between each student and the 140 electronic homework problems assigned over the course of the semester. Recorded data for each student-problem includes correct and incorrect answers submitted, hints, and solutions requested, with a time stamp for each interaction. Starting from the results of [9], we developed two statistical algorithms to indicate copying: one based on the interactions within a particular problem, and the other on the context of all other problems solved by a student during an assignment. Each used Bayesian analysis to determine the probability of copying for each completed problem [9], and a problem was deemed copied if either algorithm assigned a probability > .75. We believe that there exists a 5% chance of a false positive detection when applying our algorithm. Although our probabilistic results may be difficult to sustain in front of an academic disciplinary committee, there are specific cases of students who copied < 10% of all problems whom we are certain received outside help on some of those problems. We term the 17% (N=72) of the (428) students who copy more than 30% of their assigned homework to be "repetitive" copiers. Of these, 32 (7.5% of the class) copied over half of their answers.

We have no reason to believe that this class is atypical of US college courses insofar as homework copying is concerned. First of all, it is a large class taught in the traditional lecture-recitation format. Secondly, a standard self-reported questionnaire was administered to this class in Fall 2005, and revealed that their self-reported cheating rate was slightly below the national average, and that the students tended to view homework copying as slightly more serious than the average US college student [9]. That said, there are two features that make this class likely to have a higher cheating rate than the average MIT course: it is a required service course not taken by most prospective physics majors (who are predominately in the 30% of the entering class who have advanced standing in physics or who elect to take the honors course), and first term courses are the only ones that are graded pass-no record which offers little penalty for not learning the material well.

Patterns of Copying. The fact that copying is repetitive indicates that it should follow some patterns. These patterns address questions like: "is the copying constant or does it increase during the semester?", "do copiers tend to delay their work until closer to the due date?", do copiers compensate by working more practice problems to prepare for the examinations?". We observe the relevant patterns through detailed analysis of each student's solution process, revealing behavioral patterns associated with both non-copiers and repetitive copiers. In order to divide the class into copiers of various degree, we split students into three groups: students who copied more than 50% of their electronic homework (N=32 or 7.5% of all students), students who copied 30-50% of their electronic homework (N=40 or 8.0% of all students), and students who copied < 30% of their electronic homework. While this last group contains some students who copied some problems, its term averaged copying percentage is 7% which probably does not have a great effect on the learning of this group, which we can therefore take as a control group.

The first pattern is the marked increase in copying during the course of the semester (Fig 2-1, A). For repetitive copiers, two distinct increases are observed, the first increase is at assignment 3 which is preceded by a relative absence of homework copying. Because copying requires both a copier and a supplier, the developing social structure between unfamiliar freshman students could account for this absence of copying before assignment 3. However, this timing is also consistent with the time when enthusiastic students realize that MIT demands much more work than high school. The second increase occurs with assignment 8, which is accompanied by increased copying by some who did not previously copy. Since midterms for other freshman classes were scheduled between assignments 7 and 10; this copying may reflect mounting academic pressure as the term progresses. Changes are not seen prior to any of the three "mid-term" exams; probably because the assignment prior to an exam was a review, consisting of optional, not for credit, problems.

The second pattern concerns the distribution of student effort throughout the weekly assignment cycle (Fig 2-1, B). Each assignment cycle was 7 days in length, and each assignment was due at 10 PM on Tuesday evening, with a gradually increasing penalty for lateness over the next 30 hours. Over 70% of all interactions made by repetitive copiers were submitted either in the final 24 hours of the cycle or after the deadline (lateness carried a penalty that increased linearly to 50% over the course of the following 30 hours). By comparison, only 28% of all interactions made by all other students were submitted during the final 24 hours or thereafter. 13% of all interactions submitted by the repetitive copying group were submitted late, compared with only 4% of all other student's interactions. Surprising is the relatively steady rate of interactions by the main group of students - they work evenly over the three day period preceding the due date, with 20-30% of all interactions submitted per day. Although evidence of the late attention of the repetitive copiers to their assignments is overwhelming, we do not know whether they copy because they have procrastinated until the end of the assignment cycle and are left with no alternative, or whether they wait to the last few hours because they have already made a conscious decision to copy the assignment (which should allow them to answer the questions quickly). Their much larger fraction of late submissions suggests that, if the first alternative is not the case, then they clearly lack good time management skills. Also, students who copy more than 50% of their homework submit more late answers (16 +/- 3% vs. 10 +/- 2%) than students who copy 30-50% of their homework, reinforcing our observation that the former are hardened copiers and the latter are opportunistic copiers.

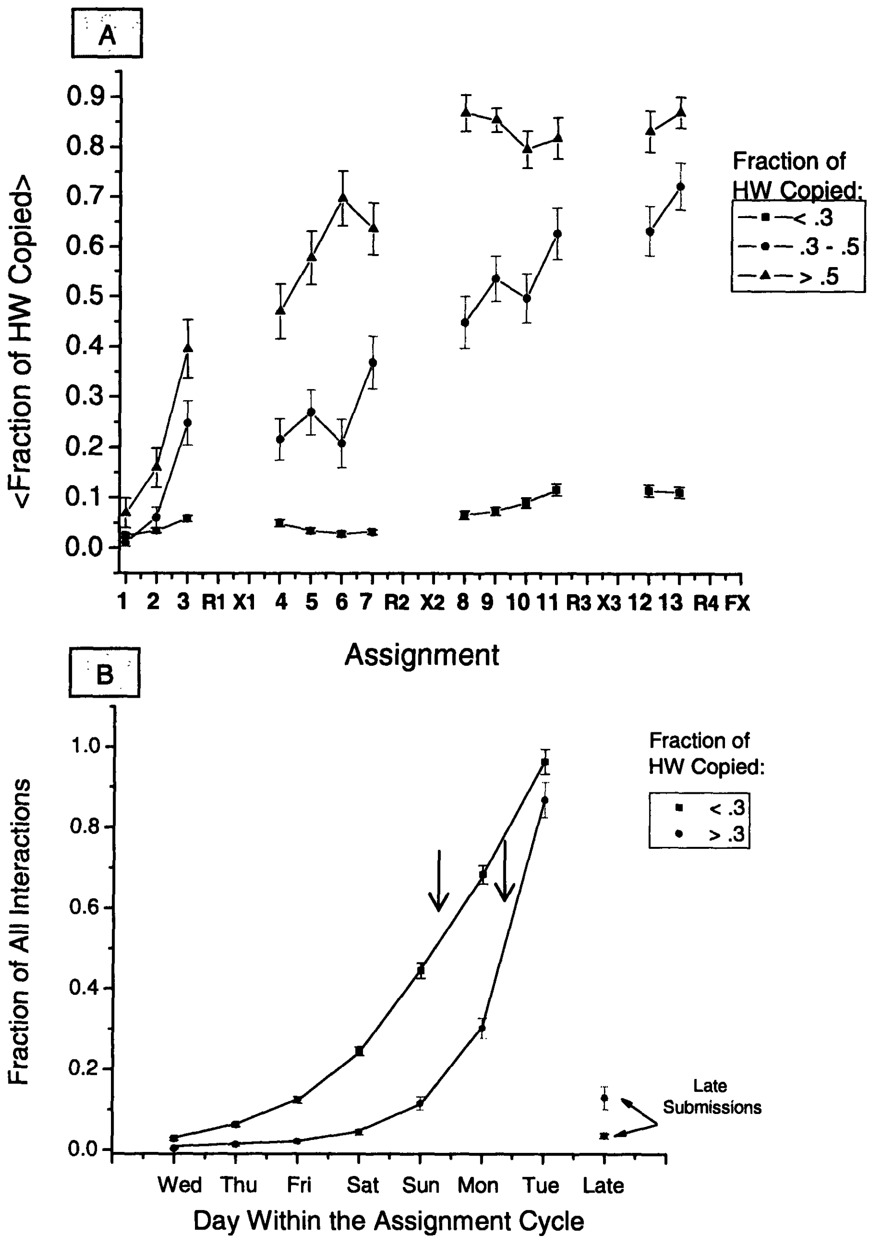

Figure 2-1: Temporal patterns of homework copying. (A) Average fraction of electronic homework problems copied vs. time during semester for three groups. A dramatic rise is evident throughout the semester. R1-R4 and X1-X3, FX are the review assignments and the course examinations respectively. (B) Fraction of all submitted interactions vs. day within the weekly assignment cycle for both repetitive copiers and other students. The arrows show the day/time of the median interaction for both student groups. By Sunday night (10PM), the main group of students has completed half of all interactions. By comparison, the repetitive copiers don't reach the same point until noon on the due date, 36 hours behind their peers.

The next pattern relates the amount of electronic homework copying with the order of the problem within the assignment (Fig 2-2, A,B). There is a clear relationship between the order of the problem within the assignment and the fraction of students that copied that problem. The fraction of students copying gradually increases as the problem order increases and peaks after problem #10. A sigmoidal fit was applied to the data, with significantly better results than a linear least squares fit, R^2= .95 vs. R^2 = .86. The sigmoidal nature of the data suggest that copying is low until a specific number of problems is reached.

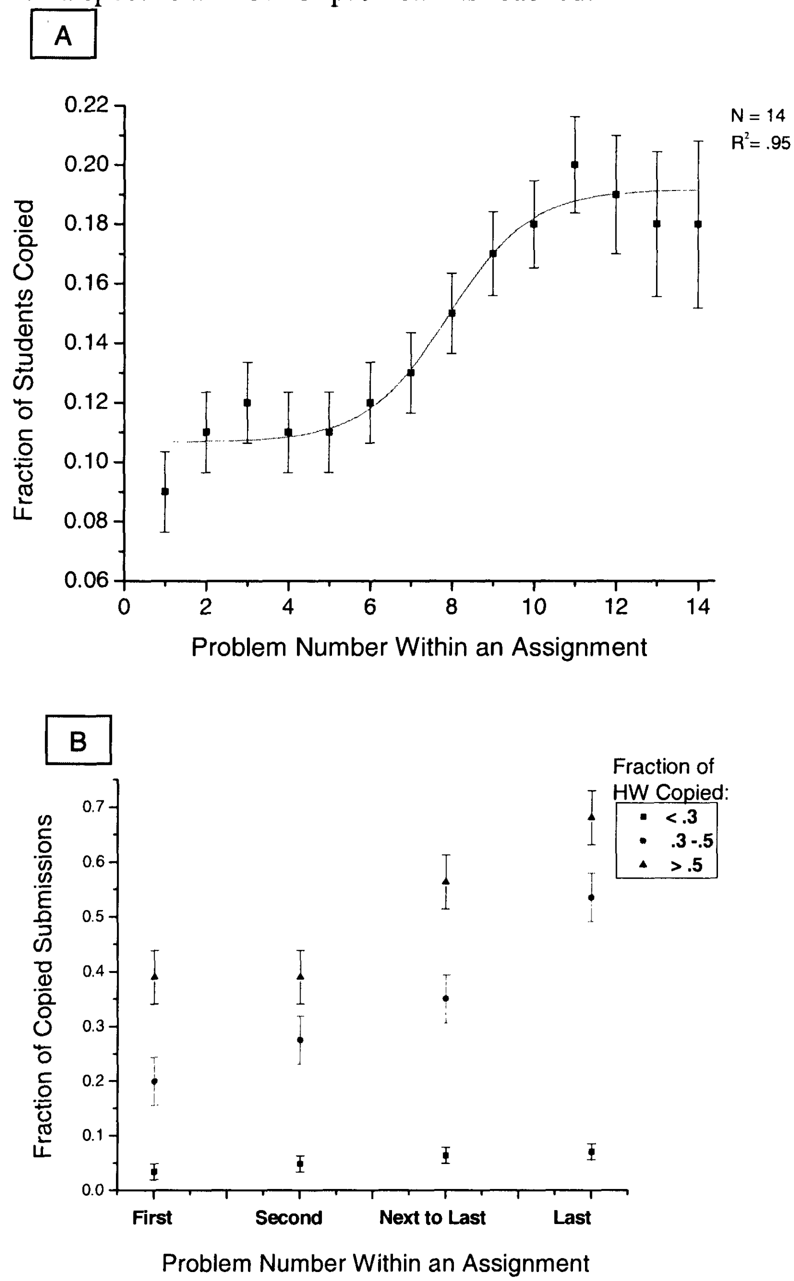

Figure 2-2: Electronic homework copying, assignment length, and problem order as completed. (A) Fraction of students copying a problem vs. its position in the assignment. A sigmoidal fit best describes the data observed, R^2 = .95. This suggests that a length "ceiling" to

assignments might reduce homework copying of repetitive copiers. (B) Fraction of each group copying vs. problem order on assignment. Repetitive copiers copy more problems at the end of the assignment, as compared to all other students whose copying remains constant within error across an assignment.

The next pattern relates the fraction of students who copied a problem and the relative difficulty of that problem (Fig 2-3, A,B,C). Relative difficulty that a student experiences when solving a specific problem is measured using an algorithm based on a linear combination of the student's time to first correct response, the number of wrong answers submitted, and the number of hints requested [8]. Overall, we observe a positive correlation, $r = .39$, $p < .001$, between the difficulty of a problem and the fraction of students that copied it. We also observe slightly higher positive correlations as copying increases during the term. Within each copying group, we observe an increasing correlation between the fraction of students that copied a problem and the difficulty of the problem (Table 2-1). From the intercept of the regression line, we also note that <10% of the < 30% copiers typically copy a problem with zero difficulty, whereas more than 50% of repetitive copiers typically copy even zero difficulty problems (no one would make any mistakes or request any hints on a zero difficulty problem). From the reported slopes in Table 2-1, we observe ~5% increase of copiers from both repetitive copying groups for each incremental increase in problem difficulty, whereas we expect less than 1% increase from the < 30% copiers as problem difficulty increases.

The last pattern revealed is that repetitive homework copiers do significantly less practice problems than all other students (Fig 2-3, B). A week prior to each examination, the course instructor posted an average of 15 optional, not for credit, practice problems intended to help the students review for the impending exam. Prior to each exam, the main group of students attempted an average of 57 +/- 1% of all posted practice problems, compared to the repetitive copiers who attempted an average of 43 +/- 2% of all posted practice problems. However, the main group of students attempted similar fractions of practice problems across the term whereas the repetitive copiers attempted fewer and fewer problems with each successive exam.

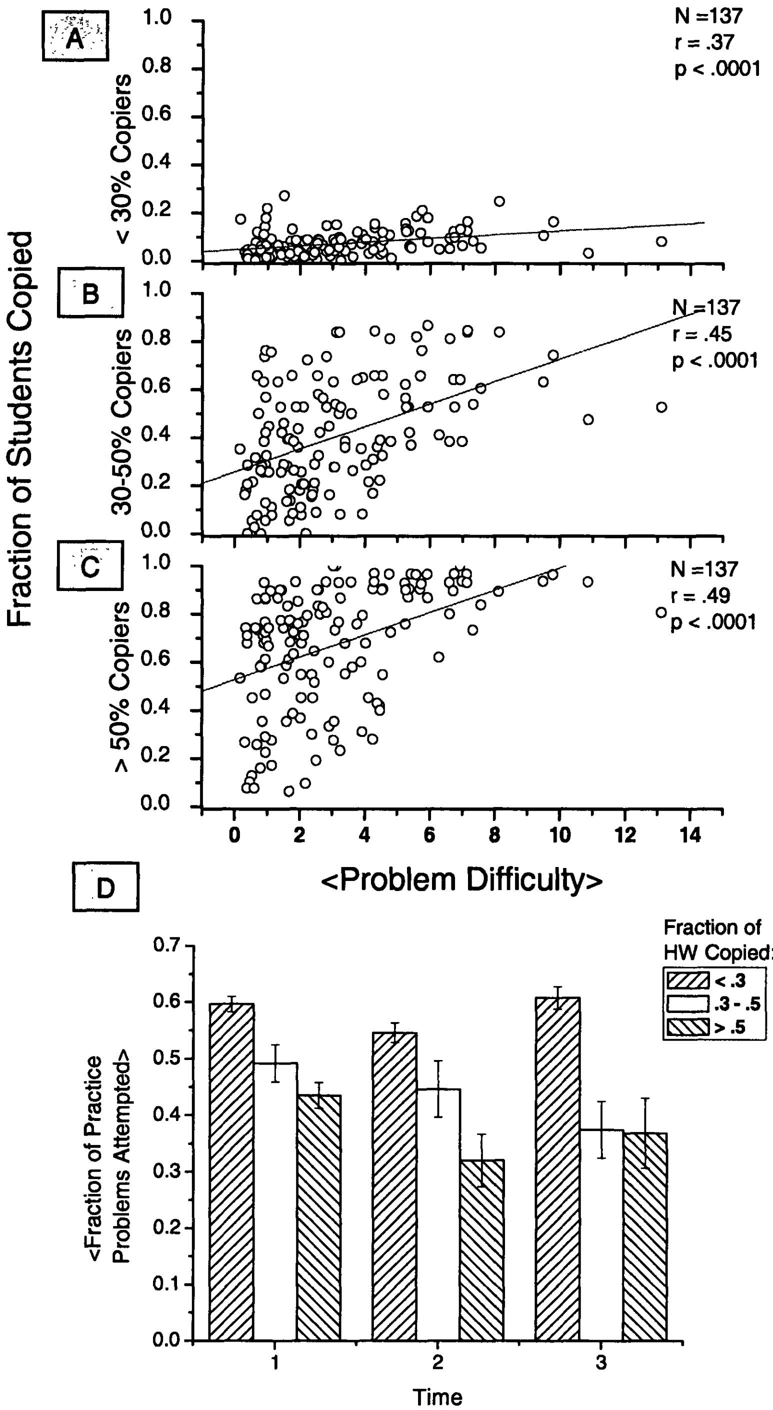

Figure 2-3: Homework copying vs. problem difficulty, and practice problems. (A) Problem Difficulty and students who copy < 30% of homework. A correlation of r = .35, p <.0001 is observed between the fraction of students that copy a problem and the relative difficulty of the problem. (B) Problem Difficulty and students who copy 30-50% of homework. A correlation of r = .45, p <.0001 is observed between the fraction of students that copy a problem and the relative difficulty of the problem. (C) Problem Difficulty and students who copy >50% of homework. A

correlation of r = .49, p <.0001 is observed between the fraction of students that copy a problem and the relative difficulty of the problem. (D) Repetitive homework copiers do significantly less optional practice problems than all other students. Students who copied between .3 - .5 attempt fewer practice problems than the main group of students and attempt fewer problems with each exam. Students who copied more than .5 attempt the smallest fraction of practice problems. The main group of students (< .3) continue to attempt a similar fraction of practice problems with each exam.

Copying Group	r	slope	error	intercept	error
<30%	0.37, p< .0001	0.0078	0.001	0.047	0.006
30-50%	0.45, p < .0001	0.047	0.007	0.257	0.029
> 50%	0.49, p < .0001	0.046	0.008	0.526	0.032

Table 2-1: Copying group and correlation with problem difficulty.

Consequences. The first consequence of repeated homework copying is severely declining performance as the semester progresses. Five primary performance measurements were administered during the Fall 2003 semester: A diagnostic test, 3 "mid-term" exams, and a course final exam. At the start of the semester, all copying groups students entered the class with the same prior ability base as measured by the diagnostic Mechanics Baseline Test (Fig 2-4, A) . However, repetitive homework copiers scored progressively lower on each successive test as the semester progressed. By the course final exam, students who copied 30-50% of their electronic homework scored 1 standard deviation below the main group of students and students who copied more than 50% of their electronic homework scored 1.3 standard deviations below all other students. Breaking students into deciles according to the amount of homework copied, and fitting the scores of each decile with a linear least squares regression line, we observe that the only student group with a positive slope between the MBT diagnostic test and the course final examination are students who copy < 10% of all homework problems. All other deciles exhibit a negative slope across the course examinations, with the slope of the regression line becoming more negative as the copying increases.

	Fall 2003				
Decile <Average Copied>	< .1 <.04>	.1-.2 <.15>	.2-.3 <.24>	.3-.5 <.39>	> .5 <.61>
Slope	0.0059	-0.0077	-0.0029	-0.013	-0.016
Slope Error (+/-)	0.001	0.003	0.004	0.004	0.004

Table 2-2: Average change of term exam performance by copying decile. Slope is measured in exam score per average fraction of problems copied.

The most dramatic consequence of copying is that a student's final exam t-score shows a very significant negative correlation with the fraction of homework problems copied and a student's final exam t-score, $r = -.43$, $p < .0001$ (Fig 2-4, B). The slope of the regression line indicates a -2.24 +/- .23 σ learning effect size for students who copy every homework problem. This confirms the effect size found from our earlier study [10] of how various course elements correlated with learning on the final exam. Since neither that study, nor any others we know of, show such a large learning effect associated with doing written homework, we suspect that copying written homework would not result in such a serious degradation in final exam performance as does copying electronic homework – it is nevertheless likely to be quite harmful to students' academic success.

The second consequence of repetitive homework copying follows directly from this decreasing exam performance: Students who repeatedly copy their electronic homework have a much higher attrition rate than students who do not. During the two semester required Physics sequence, students can encounter four primary pitfalls: Drop or fail Newtonian Mechanics and drop or fail Electricity and Magnetism. While only 5% of non-copiers failed Newtonian Mechanics, 20% (N=8) of students who copied between 30-50% of their electronic homework and 28% (N=9) of students who copied more than 50% of their homework failed to matriculate to Electricity and Magnetism (Fig 2-4, C). The 17% of the class population comprised of repetitive homework copiers accounted for 50% of all class failures (drop rates were unavailable for the fall semester). Repetitive homework copiers continue to have abnormal drop and failure rates the second semester: ~10% of the remaining repetitive copiers drop or fail Electricity and Magnetism compared with 2% of all other students. Over the two semester sequence, repetitive homework copiers exhibited a 31% attrition rate compared to 7.5% for all other students, a sorry result for students who started the year essentially even with their contemporaries.

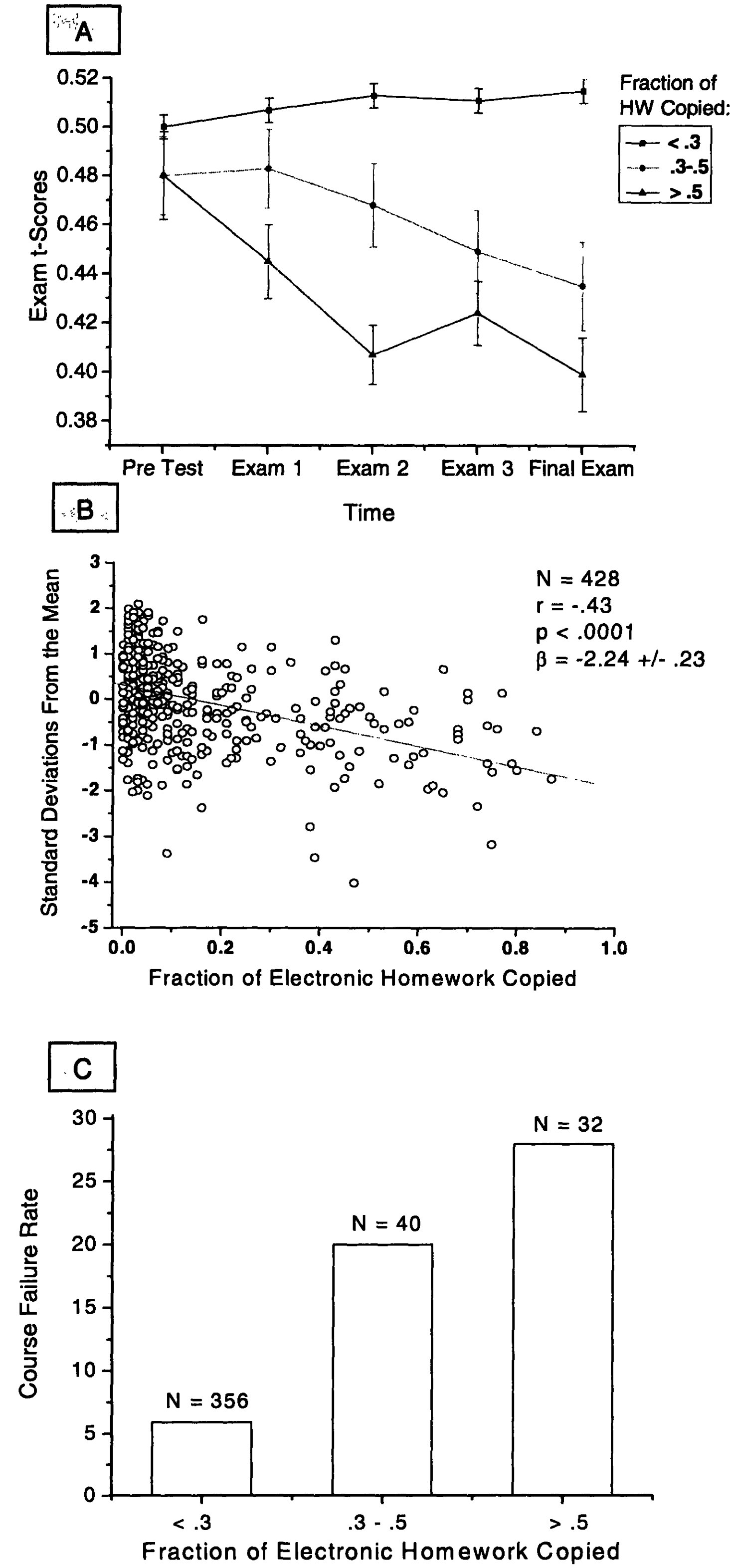

Figure 2-4: Correlates of electronic homework copying. (A) Exam performance using scaled t-scores for each group of students shows a severe decline associated with electronic homework copying. The calculated error for each exam is the standard error of the mean. (B) Final exam

performance vs. fraction of electronic homework problems copied. We observe a significant negative correlation, Pearson correlation coefficient r = -.43, p < .0001. (C) Attrition rate for repetitive copiers (.3-.5 and > .5) and the main group of students (< .3). The listed N above each group of students is the number of students in the group.

Summary, Discussion, and Implications.

Direct observations of copying of electronic homework in the required Newtonian Mechanics class at MIT were conducted during the Fall 2003 semester. The rate of homework copying - 14% of all problem answers submitted - is not much greater than reported on a self-reported cheating survey administered to the students, a rate that in turn is slightly below the national average of self-reported copying or unauthorized collaboration. Although most of the copying is confined to the 17.3% of the students who copy over 30% of their answers, a large fraction of students apparently copy over 5% of their problems. In the rest of this section we discuss the implications of the behavioral patterns involved and the academic implications of such copying for students and teachers.

Is the effect of homework copying on exam performance observed to be a local effect (e.g. proportional to recent copying) or a cumulative effect over the whole term? Observing the slope of the regression line from the correlation of each successive exam with the cumulative fraction and the local fraction of problems copied prior to each exam gives us some insight. We believe that that the effects of copying are more local than cumulative (Table 2-3). We observe similar, increasing, significant correlations for the both the relationship between local and cumulative copying and exam performance. However, the slope of the regression line adjusted for the number of problems assigned, such that we measure the exam decline per problem copied, shows that the effects of copying are more local than cumulative. The average inter-exam score decline on exams 2 through the final (on exam 1 "local" and "cumulative" are the same) is 30% lower than the decline associated with cumulative problem copying, -.39 +/- .02 vs. -.27 +/- .01.

Local Copying (e.g. Problems copied between successive exams)							
Test	r		Slope	Error	Problems	Slope/Problem	Error
Exam 1	-0.14	p < .001	-0.11	0.04	26	-0.46	0.0150
Exam 2	-0.31	p < .0001	-0.16	0.02	43	-0.33	0.0400
Exam 3	-0.35	p < .0001	-0.14	0.02	46	-0.27	0.0500
Final Exam	-0.37	p < .0001	-0.12	0.01	23	-0.49	0.0400
Cumulative Copying (e.g. Total problems copied prior to each exam)							
Test	r		Slope	Error	Problems	Slope/Problem	Error
Exam 1	-0.14	p < .001	-0.11	0.04	26	-0.46	0.0500
Exam 2	-0.29	p < .0001	-0.19	0.03	66	-0.28	0.0400
Exam 3	-0.32	p < .0001	-0.18	0.02	115	-0.16	0.0200
Final Exam	-0.45	p < .0001	-0.23	0.02	138	-0.17	0.0100

Table 2-3: Local and Cumulative Effects of Copying and Exam Performance. Reported slope for local copying is the change from the previous exam whereas slope for cumulative copying is the change from the MBT Diagnostic Test.

All of the observed patterns of student behavior are consistent with the notion that students copy homework in response to time pressure: repetitive copiers copy a surprisingly larger fraction of homework towards the end of the semester, and also postpone the majority of their "work" on assignments until the few hours prior to the time it's due. Other patterns support this contention: repetitive copiers copy 30% of the first problems on an assignment, and ~60% of the last and the copying fraction increases significantly for problems later than #7 on the assignment. Furthermore, independent of problem position, there is more copying on more difficult problems.

What is the root cause of copying homework? Three facts suggest that repetitive copiers become more overwhelmed as the semester progresses rather than having a clear-headed plan to maximize their grade to effort ratio:

1. In spite of decreasing performance over the term, they copy an increasing fraction of their problems as the term progresses.
2. These students, who know they are copying more and also doing worse on the periodic examinations, work fewer and fewer pre-exam practice problems relative to non-copiers,
3. They submit a much larger percentage of their problems after they are due in spite of the fact that it is easier to budget the relatively well-known time to copy the remaining problems than the time to actually solve them.

We have demonstrated a strong correlation between homework copying and poor test performance. This confirms the majority opinion of both students and faculty that not doing the homework is a cause of test failure. Together with the fact that the cheating precedes the poor test performance, this argues that copying causes the observed correlation with poor exam performance. (Besides, the alternative suggestion that doing poorly on tests causes students to copy more homework seems illogical.)

In part motivated by a desire to provide special tutoring for at risk students, we have found a prediction algorithm to identify, early in the term, students who are at risk for poor final examination performance. We performed a multiregression involving amount of homework copying C, average skill of students determined from the online homework tutor, S, diagnostic MBT score D, and first exam score X1, and written homework grade to that point, H – each variable being normalized by its standard deviation (z-score). The result was:

E1. Final Exam Grade = - 0.36 C + 0.21 X1 + 0.19 S + 0.17 D

where student skill is measured using the algorithm in [8], and written homework grade was insignificantly correlated with the final grade. Among these variables, the strongest predictor of a student's final exam t-score is the fraction of electronic homework problems copied, $\beta = -.36$. The model with the above variables has a correlation with the final exam of $r = .73$, $p < .0001$, and accounts for 53% of the variance in predicting a student's final exam score. An interesting implication of this is that working hard (i.e. not copying) is a better predictor of final exam success than is doing well on any of the performance measures (and especially the diagnostic, the best measure of "native ability" at the start of the course). Perhaps the general (American) view that success in science comes to the most gifted is wrong, and hard work counts more in the end.

For educators, science teachers, and other faculty, our results are a call to action to confront and reduce the most serious impediment to learning - homework copying. (That has been the approach at MIT, see [9]). Reducing homework copying offers the most obvious route to reducing course failures and increasing student learning. By emphasizing the importance of faithful completion of homework, and providing individualized remediation for at-risk students identified using Eq. 1, we believe that about ½ of current final examination failures could be avoided.

For students, the implications of our study are clear: homework copying may seem like a harmless infraction (e.g. compared with exam cheating) but no action will reduce your final exam performance (and associated learning) more. All patterns observed point to one conclusion. Success in the Newtonian Mechanics physics course at MIT can be assured for a reasonable price: time and effort spent on homework.

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2.2 Patterns and Consequences of Homework Copying from Fall 2005

We have also studied copying in the Fall 2005 introductory course, a variant of the former course in that it is taught in a studio format (see below). We further investigate the patterns and consequences of electronic homework copying from the Fall 2003 and the Fall 2005 Newtonian Mechanics courses. First, copying demographics are reported and contrasted with our summary of individual and environmental factors reported in our literature review. Also, for each of the Fall 2003 behavioral patterns reported in Chapter 2.1, the corresponding patterns from the Fall 2005 class are reported and contrasted with the 2003 class. Consequences associated with repetitive homework copying from the Fall 2005 class are also reported.

8.01: Fall 2003 and Fall 2005 (TEAL).

Before we contrast observed patterns between the Fall 2003 class and Fall 2005 class, we would like to provide perspective on important structural differences between the two courses. The Fall 2003 8.01 course was structured around the lecture recitation format. One primary instructor was responsible for lectures. Lectures were held three times a week for an hour each period, and attendance by students was not required. Two weekly recitation periods were scheduled as well; these typically consisted of a faculty member answering homework questions or elucidating points they consider important or murky in the lectures. Students could spend a total of five hours per week between both lecture and recitation section, but neither is required. Students also completed two homework assignments per week - an electronic homework assignment (MasteringPhysics) and a written homework assignment. This class also did not include a laboratory component, as had been the case in the required physics courses at MIT for over 30 years. Overall, the Fall 2003 class was not unlike the required service courses taught at many colleges and universities nationwide.

The Fall 2005 class format, formally known as TEAL (Technology Enabled Active Learning) was the result of five years of prototype testing at MIT. TEAL is basically similar to the studio physics developed at RPI and used in many other places. IT seeks to combine various activities that engage students, enabling a rich learning environment. The Fall 2005 8.01 class was the first year that it was the main version of 8.01, expected of all freshmen except those that either placed out of the course or elected a more mathematically challenging course. The course structure consisted of 8 sections, with one instructor responsible for teaching each section. Each section consisted of ~75 students, and each section met for five hours each week. During class periods, students are engaged with demonstrations, hands on experiments, visualizations, and group problem solving sessions. Students are broken into groups of no more than 3, and each student group has access to a laptop that is used to enhance demonstrations and enable computer-aided analysis of experimental data. Students were assigned two electronic homework assignments each week, again thru MasteringPhysics, and one written homework assignment each week. Electronic homework assignments were much shorter than Fall 2003 assignments and contained only 3 or 4 problems. The first electronic assignment of the week was designed to introduce students to new concepts while the second homework assignment was designed to challenge the student's problem solving abilities within that conceptual domain.

Demographics of Copying: Fall 2003 and Fall 2005.

This section will investigate the relationship of demographic variables to the fraction of electronic homework copied during the Fall 2003 and Fall 2005 Newtonian Mechanics classes at MIT. Published studies show that certain demographic factors are related to higher reported rates of cheating, while data related to other demographics are either inconclusive or incomplete [see Chapter 1.2: Individual and Environmental Factors and Cheating]. Existing data support claims that factors such as age, gpa, and school size are related to higher reported rates of cheating among college undergraduates. Factors such as sex, ethnicity, morality, academic major, class year, and school type are inconclusive or incomplete with regards to their relationship to reported rates of cheating. This section will explore the relationship of many demographic factors to detected homework copying. These factors include sex, age, class year, ethnicity, high school class size, high school type (public or private), concurrent enrolled math classes, academic major, SAT II Physics score, SAT II Math score, and a numerical index predicting MIT grade performance(as calculated by the MIT Admissions Office).

Gender. In our review, we concluded that gender differences, and their relationship to cheating, could not be drawn conclusively from existing data. In this study, our total sample consisted of 456 males and 469 females. Combining gender data from both the Fall 2003 and the Fall 2005 classes, we observe that male students averaged ~40% more homework copying than female students, 13.1 +/- .06% to 8.0 +/- .05%. At all levels of homework copying, more males than females copied (Figure 2-5) even though there were 3% more females in the sample.

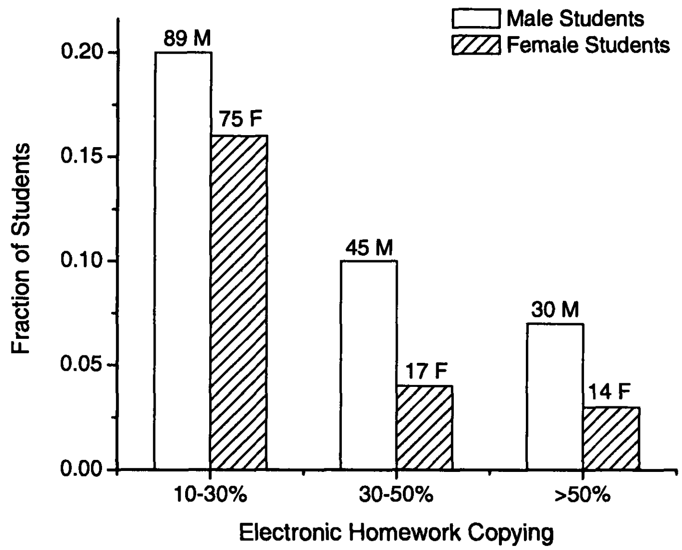


Figure 2-5: Male vs. Female Electronic Homework Copying. Significantly more males than females were detected copying electronic homework problems. The reported numbers above each bar are the respective number of males (M) and females (F) inclusive in each copying group.

Although we can conclude that male students copied significantly more homework than female students, we observe that male and female student performance on the 8.01 course final examination was similarly affected by the same amount of homework copying (Table 2-4). We observe slightly higher correlations for the relationship between male copying and final exam performance; however, this is due to the larger standard deviation of male copying. We can remove the effect of each population's variance by observing the slope of the regression line (β); we evidence little difference between the effects of homework copying on final exam performance within each gender.

	r	Confidence	β	N
2003 Males	-.52 +/- .08	p < .0001	-.27 +/- .03	214
2005 Males	-.39 +/- .06	p < .0001	-.21 +/- .03	209
2003 Females	-.38 +/- .07	p < .0001	-.25 +/- .04	242
2005 Females	-.29 +/- .06	p < .0001	-.27 +/- .05	260

Table 2-4: Male and Female Copying vs. 8.01 Final Exam Performance

Ethnicity. Because few studies have directly investigated the relationship between ethnic background and cheating, in Chapter 1 we concluded that more research was required to formulate conclusions. For each of 7 ethnic groups, the average fraction of electronic homework was calculated; data are summarized in Figure 2-6 below. No statistically significant differences are observed between ethnic groups with respect to the average fraction of electronic homework copied.

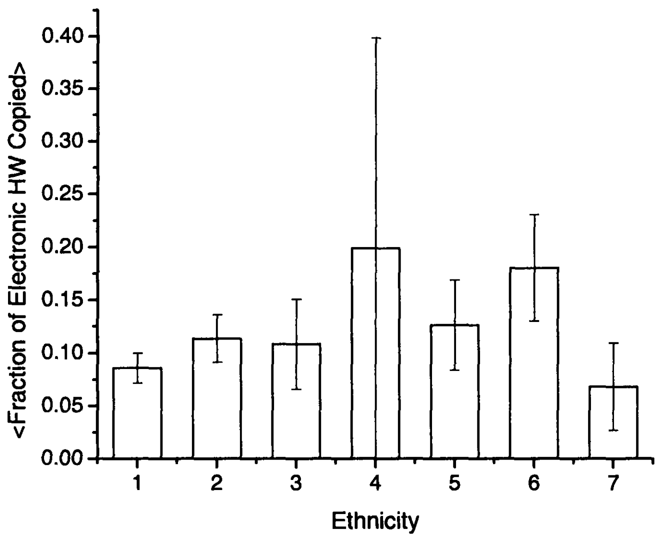


Figure 2-6: Ethnicity and Electronic Homework Copying. Key: 1 – Caucasion, 2- Asian, 3 – Black, 4 - Native American, 5 – Mexican, 6 – Puerto Rican, 7 – Other Hispanic. No statistical differences are observed between different ethnic groups and homework copying.

Age. In Chapter 1 we concluded that older students reported cheating less than younger students, perhaps as a function of task orientation in courses related to their academic major, or perhaps simply as a function of greater maturity. For each student age, the average fraction of electronic homework is calculated. We observe no differences between 17 year old students and 20 year old students (Figure 2-7). 21 year old students averaged lower rates of homework copying; however, the sample included only 4 students who copied. Thus, we conclude that student age is not related to homework copying. National studies that have found age differences in cheating probably involve a larger range of student ages, whereas our study is limited to students between the ages of 17 and 21.

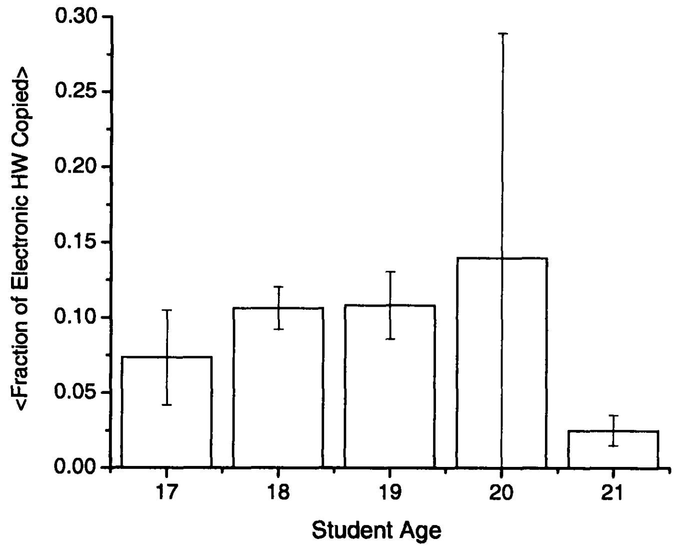


Figure 2-7: Student Age and Electronic HW Copying. No relationship is observed between the homework copying and student age (the low value for age 21 may reflect that there were only 4 students in this age group).

Class Year. In Chapter 1 we concluded that the relationship between cheating and class year required more research. For each class year, the average fraction of electronic homework copied is calculated. Because of the small sample size of non-freshman, data are combined into freshman class and upperclass students. No significant difference is observed between freshman and upperclassmen homework copying. In Fall 2003, freshman (upperclassmen) copied an average of 14 +/- .1% (16.5 +/- 6%). In the Fall 2005 class, freshman (upperclassmen) copied an average 8 +/- 1% (11 +/- 5%).

Academic Major. In Chapter 1 we concluded that more research was required to establish any relationship between cheating and academic major. Academic majors were obtained through the registrar's office and grouped into science, engineering, business, and other majors. Students from the Fall 2005 class still have not declared majors, so only information from the 2003 class could be analyzed. Business majors copied an average 25.8 +/- 3.1% of their electronic homework, compared with 12.0 +/- 2%, the weighted average of all other majors. Also, science majors copied 13.3 +/- 1.4% of electronic homework and engineering majors copied 11.0 +/- 1.0% of electronic homework. At least at MIT, and within this required science course, we conclude that business students copied significantly more electronic homework than either science students ($p-\text{value} < .001$) or engineering students (p-value < .0001).

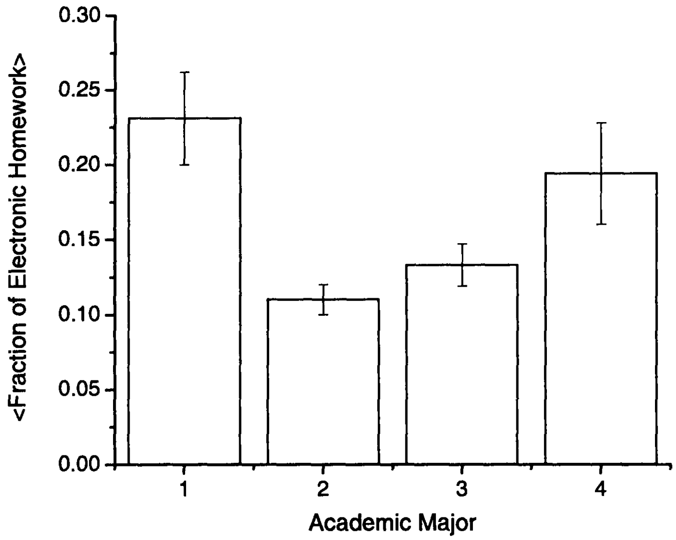


Figure 2-8: Academic Major and Electronic HW Copying. 1 – Business, 2 – Engineering, 3 – Science, 4 – Other. Management majors averaged significantly higher homework copying than the average of all science and engineering majors.

High School Size. In Chapter 1, we concluded that smaller schools were related to lower rates of self-reported cheating, and larger schools were related to higher rates of self-reported cheating. Here, we investigate a similar factor: the size of a student's high school prior to entering MIT. We find that high school class size is not related to electronic homework copying. For Fall 2003 students, we observe a Pearson correlation coefficient $r = -.04$, $p < .5$; for Fall 2005 we observe $r = -.05$, $p < .4$. Thus, we observe no relationship between a student's high school class size and electronic homework copying.

High School Type: Public or Private. In Chapter 1, we concluded that private colleges were related to lower rates of self-reported cheating, and public colleges were related to higher rates of self-reported cheating. Here, we investigate a similar factor: whether a student's high school prior to entering MIT was a public or private school. Students who attended a public high school (N = 665) prior to matriculation to MIT copied an average 10.1 +/- .06% of their electronic homework. Students who attended a private high school (N = 205) prior to matriculation to MIT copied an average 12.1 +/- 1.2% of their electronic homework. Thus, we conclude that the type of high school attended prior to MIT enrollment is not related to electronic homework copying (p-value < .11).

Prior Physics Expertise. Many faculty members believe that one reason students copy their physics homework is because they have less innate physics ability than students who do not copy homework, and hence completing the assignment without help will be too time consuming.. Out of ~925 total students, 39% (N = 357) took the SAT II Physics test during high school. Within this subsample, we see significant results from the correlation between homework copying and SAT II Physics scores. A Pearson correlation coefficient $r = -.17$, $p < .001$ is observed for the relationship between homework copying and SAT II Physics score. Also, students who copied more than 50% of their homework averaged 668 +/- 11 on the SAT II Physics test whereas students who copied between 30-50% averaged 688 +/- 6 and students who copied less than 30% averaged 708 +/- 2. Thus, students who copy more homework seem to have a history of lower performance on the SAT II Physics test. Of course, this correlation could also result from another underlying cause: that students whose primary motivation has always been to minimize time spent on physics learned less in high school, as evidenced by low SAT II scores, and subsequently elected to copy their physics homework at MIT.

Math Skill. We believe success in a calculus based physics course also depends on the math skills of the incumbent student. This belief is supported our observation of the correlation $r = .33 \pm .09$, $p < .0001$ for the relationship between a student's SAT II Math score and performance on the 8.01 final exam. Thus, we also investigated the relationship between a student's math skill and electronic homework copying. Math skill will be quantified using three measures: SAT II Math score, number of concurrent math classes enrolled, and the highest level of math class concurrently enrolled while taking 8.01.

First, we investigate the relationship between a student's SAT II Math score and homework copying. Every student enrolled had an SAT II Math score on record. We observe a Pearson correlation coefficient $r = -.07 \pm .16$, $p < .5$ ($N = 924$) for the relationship between a student's SAT II Math score and their fraction of homework copied. Also students who copied more than 50% of their homework averaged 753 +/- 7 on the SAT II Math test whereas students who copied less than 30% averaged 754 +/- 2. Thus, we conclude there is no relationship between a student's SAT II Math test score and homework copying.

Next, we investigate the relationship between concurrent math class enrollment and homework copying. We will use enrollment data in a concurrent math class to extrapolate math skill. Students enrolled in higher level math classes are assigned a higher skill. Most first semester freshman are either enrolled in 18.01, single variable calculus, or 18.02 multivariate calculus. 28% of the 2003 and 2005 classes were enrolled in the advanced version of 18.01 whose second half is the first part of 18.02 (so their registration indicates both courses). 3% of students took neither of these courses-instead they took 18.03 differential equations; another 3% took no concurrent math class, and 1% took a math class higher than 18.03, including linear algebra, algebra, and theory of numbers. Math course enrollment is quantified by assigning a number 1 thru 5 to each student based on the highest level of concurrently enrolled math class (18.01 =1, 18.02 =3, 18.03 =4, >18.03 = 5) For example, students enrolled in both 18.01 and 18.02 are assigned a 2. Students enrolled in an advanced form of any math class are assigned x.2 or x.3 depending on the designation of the class. For example, a student enrolled in 18.022 is assigned 3.2, whereas a student enrolled in 18.023 is assigned a 3.3. We report an average math class enrollment score of 2.34 +/- .15 for students who copied more than 50% of their homework, 2.41 +/- .13 for 30-50% copiers, and 2.69 +/- .03 for <30% copiers. <30% copiers averaged only a 14% higher math skill than >50% copiers and we observe no statistical differences between students who copy more between 30-50% and students who copy > 50%.

Overall, we observe little evidence that a student's math course enrollment is related to the fraction of electronic homework copied.

MIT Grade Index Prediction (GIP). During MITs selection process, the admissions department assigns a numerical index to a student which is a predictor of academic success at MIT. This index runs from 0 to 50; students who score below 30 are considered to have a low chance of academic success at MIT and are generally denied admission. We report an average GIP of 39.3 +/- .9 for students who copy more than 50% of their homework and an average GIP of 40.8 +/- .2 for students who copy less than 30%. Students who copy between 30-50% averaged significantly lower GIP than other students, 36.7 +/- .7. Our results could indicate that occasional copiers are less able students and copy when they hit a difficult problem they don't understand, whereas hardcore copiers copy as a function of laziness or premeditation. Regardless, these results indicate a weak relationship between homework copying and MIT's pre-enrollment assessment of academic potential.

Overall multiregression. In addition to reporting the individual relationships of the these demographic variables with copying, a multiregression utilizing all aforementioned variables designed to predict copying is reported . Within each variable, some student data were missing; nor did we have access to academic major data for 2005 students. Thus, we report the results of several regressions. First, a multiregression with students from both classes and all of the above variables except academic major was performed (N =335 students). The largest missing variable, SAT II Physics score, was also not a significant predictor variable, thus we eliminated this variable and a second multiregression was performed (N = 891); these results are reported below in Table 2-5. Only three variables were significant copying predictors: MIT Numerical Index, Gender, and Race; these variables account for 6% of the variance in predicting copying behavior (r = .24 +/- .15). The direction of the relationship between each of these variables is as expected with the exception of gender: Lower MIT Numerical Index predicts more copying, female vs. male gender predicts more copying, and non-white ethnicity predicts more copying. The observed unexpected gender relationship may be an artifact of missing male demographic data from the sample. The regression program (SPSS) discards fields that do not contain each of the included variables. The variables school type, school size, age, class year, SAT II Physics score, and SAT II Math score were excluded because of insignificance.

Variable	B	t	significance
MIT NI	-0.153	-4.658	$p < .0001$
Gender	-0.15	4.595	$p < .0001$
Race	0.09	2.738	$p < .006$

Table 2-5: Significant demographic variables.

Effect of academic major. A final multiregression is reported using only 2003 student data in order to investigate the addition of academic major as a copying predictor (Table 2-6). Again, only three demographic variables are observed to be significant copying predictors: MIT

Numerical Index, Academic Major, and Gender. We observe the expected relationships for each significant variable, and this model also accounts for the same variance (6%) as the previous model (r = .25 +/- .10). In this case, the males copied significantly more than the females.

Variable	B	T	significance
MIT NI	-0.15	-3.059	$p < .002$
Major	0.121	2.454	$p < .001$
Gender	0.119	2.434	$p < .001$

Table 2-6: Fall 2003 significant demographic variables.

Patterns of Copying: Fall 2005 vs. Fall 2003.

The first pattern we report contrasts the amount of homework copying detected within each class (Figure 2-9). We observe that Fall 2005 students copied 8% of their total electronic homework problems, ~40% less copying than the Fall 2003 students, who copied 14% of their total electronic homework problems. In each copying group, we see evidence that Fall 2005 students copied less homework. Only 2% of the Fall 2005 class (N = 13) were detected copying > 50% of their homework; 7% of the Fall 2003 class (N = 32) was detected copying > 50%. Furthermore, a substantially larger fraction of students from Fall 2005 were not detected copying any homework, 25% vs. 5% from Fall 2003.

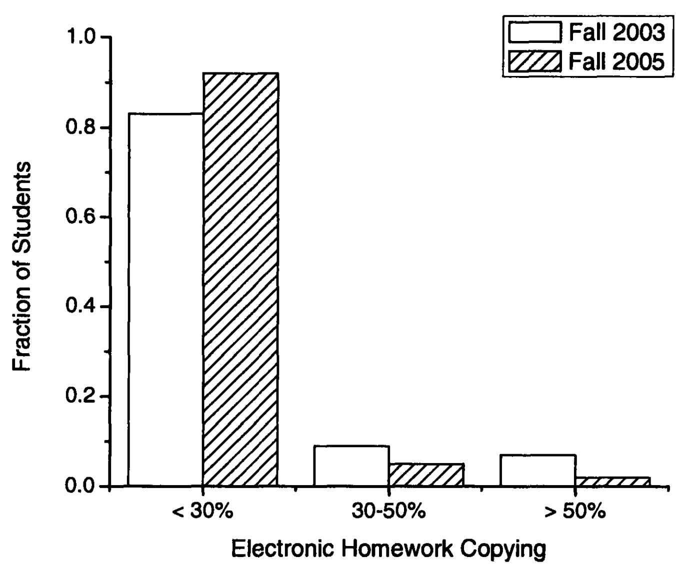
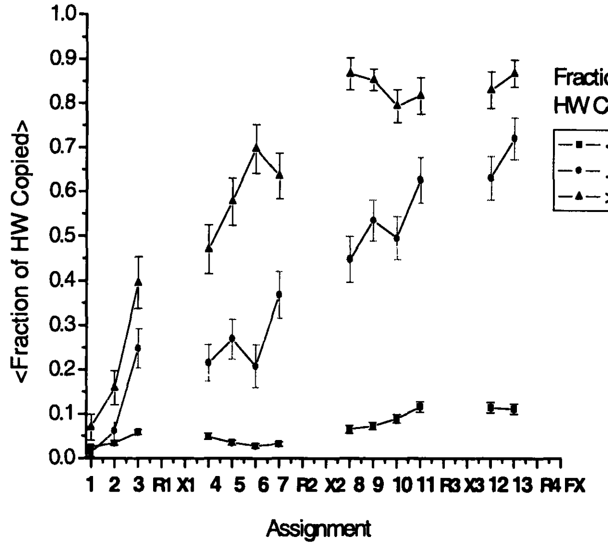


Figure 2-9: Detected homework copying from Fall 2003 and Fall 2005

For each of the behavioral patterns reported for the Fall 2003 class, we compare and contrast data from the Fall 2005 class. The first behavioral pattern reported from Fall 2003 was the increase in electronic homework copying as the semester progresses. Data from Fall 2005 show similar results (Figure 2-10) with some notable exceptions. Like Fall 2003, overall electronic homework copying increases as the semester progresses. Between assignment 1 and assignment 19, students who copied more than 50% of all homework increased the average fraction of problems copied from .20 +/- .05 to .70 +/- .05. Students who copied between 30-50% of all homework problems increased the average fraction of problems copied from .09 +/- .04 to .58 +/- .05 over the course of the semester. Students who copied < 30% of all homework problems increased the average fraction of problems copied from .01 +/- .005 to .1 +/- .01.

One distinct difference between the Fall 2003 and Fall 2005 repetitive copiers is the initial rate of homework copying, during assignments 2 and 3. The Fall 2005 > 50% copiers begin copying at a significant fraction, .45 +/- .1 whereas the Fall 2003 > 50% copiers did not begin significant copying until the 3rd assignment. This could suggest a shift in the method that students are accessing answers. Fall 2005 students may have had access to a "bible," or other compiled source of answers where the Fall 2003 students did not. Another distinct difference between the Fall 2003 and Fall 2005 > 50% copiers is observed during assignment 8 of the Fall 2005 class, just prior to the first examination. During Fall 2005, the > 50% copiers reduce homework copying by 50% just before the exams, perhaps in an effort to learn more material. However, just after the first exam, we observe a significant increase in copying, between assignment 8 and assignment 9. Again, just prior to the second exam, during assignments 16-18, we observe a slight copying reduction.

The Fall 2005 30-50% copiers begin copying at a rate below 10%, comparable to the Fall 2003 30-50% copiers. They also increase copying linearly during the first half of the term. However, after assignment 11, the Fall 2005 30-50% copiers continue copying at a constant fraction, whereas the Fall 2003 30-50% copiers continued to increased their copying fraction. At the end of the 2003 term, the 30-50% copiers both averaged .close to 69%. The < 30% copiers from both classes gradually increase their copying over the term (with the exception of one outlier assignment from Fall 2005), with the fraction of problems copied on the last assignment approximately equal for both classes, 0.1 +/- .01.



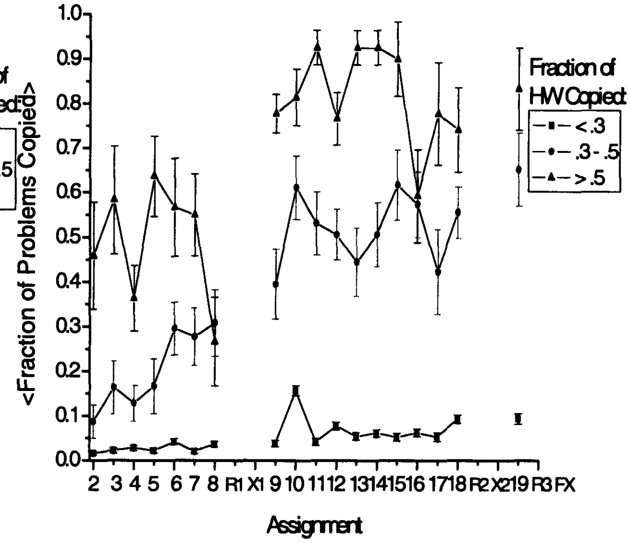


Figure 2-10: Temporal patterns of homework copying for Fall 2003 and Fall 2005 for our three groups. R1-R3 and X1-X3, FX are the review assignments and the course examinations. Copying started earlier in the term in 2005, but flattened or dropped near the end of the term. Overall there was 40% less copying in 2005.

The second pattern observed relates student interactions within the assignment cycle to the amount of time remaining before an assignment is due (Figure 2-11). The Fall 2003 assignment cycle was consistently 7 days in length, with assignments always due on Tuesday evenings, 10 PM. The Fall 2005 assignment cycle consisted of two assignments each week; the first assignment was due Sunday night at 10 PM and the second assignment was due Thursday night at 10 PM. For this reason, the time expired during each assignment cycle was normalized between 0 and 1, with 1 being the due time. For comparison, the Fall 2003 interactions vs. normalized time is included as dashed lines. We observe notable differences between the 2005 data and the 2003 data. In 2003, the main group of students do their work early and somewhat decrease their interaction rate during the final 10% of the time remaining, whereas the 2005 main group of students sharply increase their interaction rate, completing 40% of the assignment during the final 10% of time remaining. However, the repetitive copier group shows even less propensity to do the work ahead of time - they leave almost 80% (twice as much) of the assignment to the final 10% of time remaining. The median interaction for the Fall 2003 < 30% students occurs with 25% of the assignment time remaining (42 hours), while the Fall 2005 < 30% students make their median interaction with only 13% of the assignment time remaining (13 hours). We think the most likely explanation is that the students were expected to complete many more tasks with greater diversity in 2005 TEAL vs. the 2005 students: not only an extra Mastering Physics assignment, but also lab reports, furthermore, attendance in class was effectively encouraged by having in-class graded assignments in all five hours of class time.

Alternatively, the short assignments may not seem much of a challenge since the students know they will be short; hence they may be postponed with less anxiety.

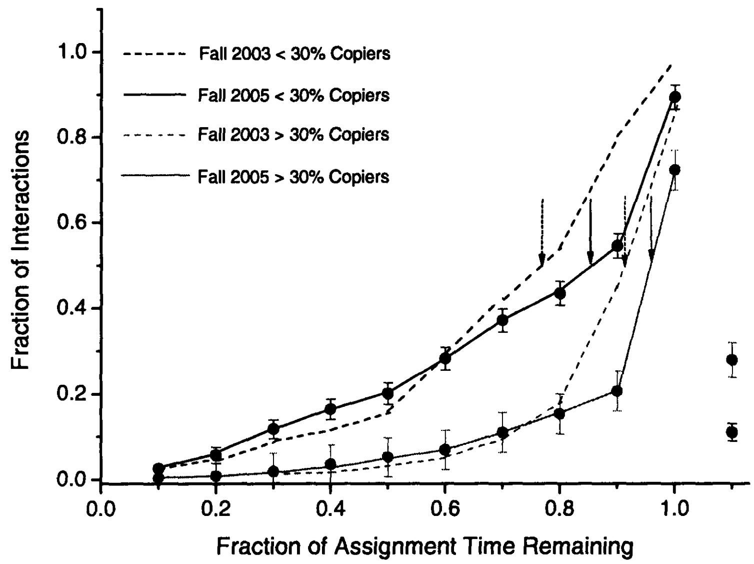


Figure 2-11: Temporal patterns of homework copying from Fall 2003 and Fall 2005 (cont): Fraction of assignment time remaining vs. copying. Arrows denote the median interaction for each group of students. The median interaction for 2003 (2005) < 30% copiers occurs with 25(13)% of the assignment time remaining. The median interaction for 2003 (2005) > 30% copiers occurs with 8(4)% of the assignment time remaining.

We also observe significantly different fractions of late interactions submitted across both groups of students and across both classes (Figure 2-12). For both classes, increasing penalties for lateness were applied, with credit for the assignment reduced incrementally to 50% over 30 hours. 75% of observed late interactions were within the first six hours after the expired due time, before students went to bed for the night. Significantly higher fractions of late interactions were submitted by students who copied > 30% as compared to students who copied < 30% in both 2003 and 2005. Also, significantly higher fractions of late interactions were submitted in 2005 as compared to 2003. Again, this may reflect the many more requirements of the TEAL version in 2005.

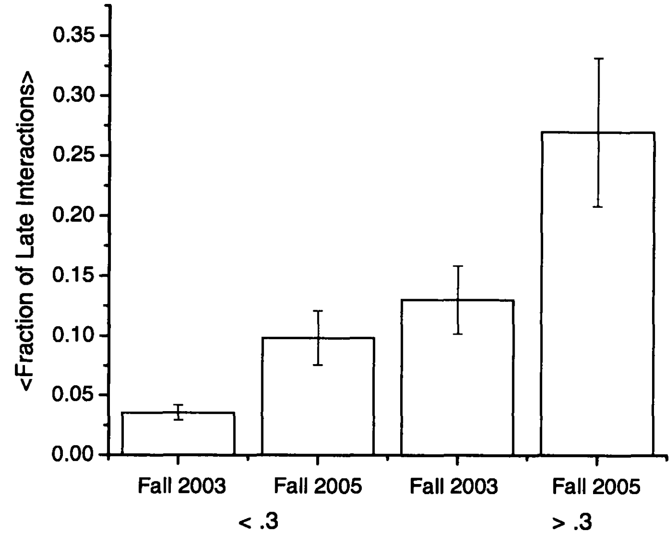


Figure 2-12: Late Interactions for Fall 2003 and Fall 2005. The repetitive copiers submitted between two and three times as many late submissions as the main group. The Fall 2005 students submitted two to three times more late interactions than their Fall 2003 respective copying group.

The next pattern relates the amount of electronic homework copying with the order of the problem within the assignment (Figure 2-13). In the Fall 2003 dataset we observed a clear relationship between the order of the problem within the assignment and the fraction of students that copied that problem: The fraction of students copying gradually increased as the problem order increased and peaked after problem #10. Due to the shortened assignment cycle for the Fall 2005 class, each assignment contained fewer problems than 2003. The Fall 2005 assignments contained an average of 3.0 +/- .15 problems, whereas the Fall 2003 assignments contained an average of 11.8 +/- .75 problems. We do not observe this pattern for the Fall 2005 class. Also, between problems 1 and 3, the Fall 2003 rate of copying increased faster than the Fall 2005 rate: 3% to 1%. We also do not observe any patterns between the amount of copying on the first problem of each assignment and the amount of copying on the last problem of each assignment. These results support our conclusion that shorter assignments might reduce homework copying.

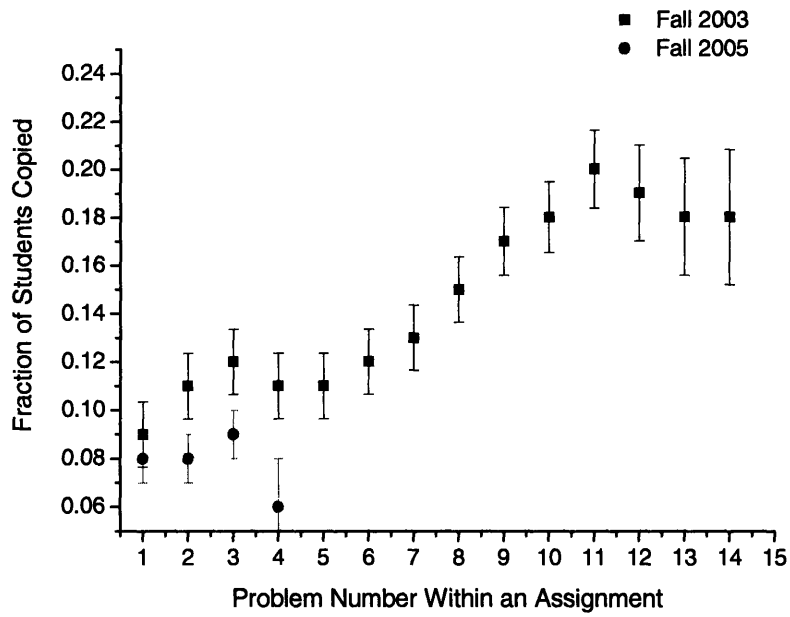


Figure 2-13. Fall 2003 and Fall 2005 homework copying vs. problem order. No relationship is observed between the assignment length and the fraction of students copying during that assignment for the Fall 2005 class.

The next pattern relates the fraction of students who copied a problem and the relative difficulty of that problem (Figure 2-14). For Fall 2003, a significant, robust positive correlation was observed between the fraction of students that copied a problem and the problem's difficulty. Surprisingly, this seemingly logical correlation is not present within the Fall 2005 class. Although a small, positive correlation is observed ($r = .1$, $p < .5$), the correlation is not significant and has a large error, +/- .13. The correlation error was calculated using Freedman's bootstrapping technique [146]. This could indicate a shift behind the reasons a student copied a particular problem. The copying in 2005 may be solely a result of time pressure, laziness, or other reasons not including the difficulty of a particular problem.

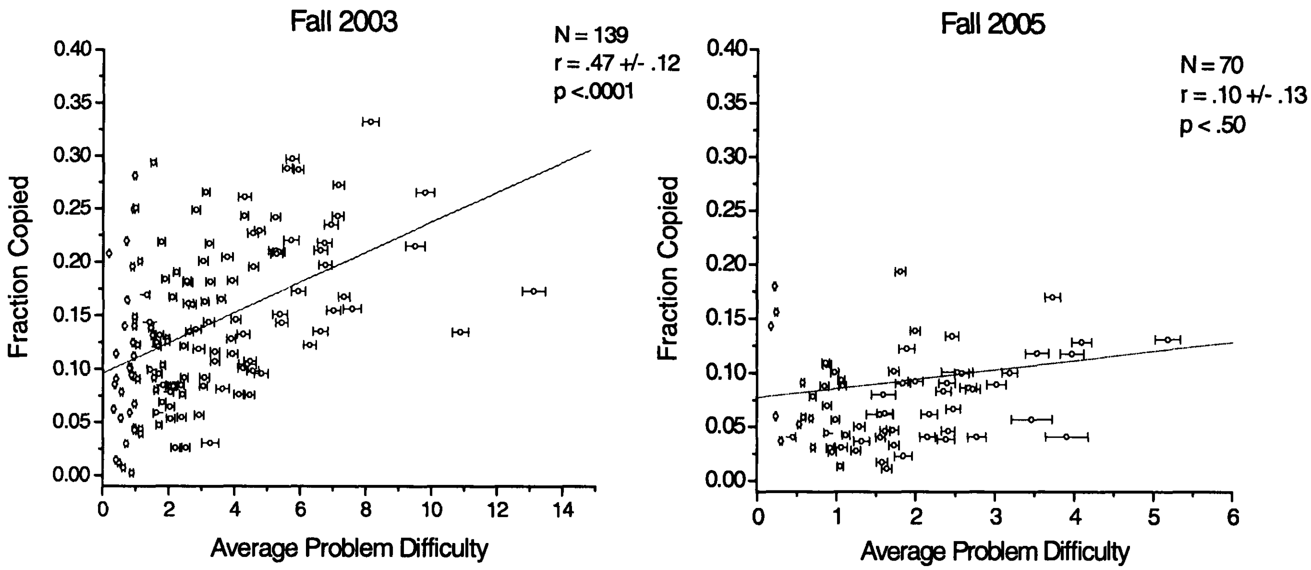


Figure 2-14: Fall 2003 and Fall 2005 homework copying vs. problem difficulty. Fall 2003 homework copying vs. problem difficulty: A correlation of r = .47 +/- .12, p <.0001 is observed between the fraction of students that copy a problem and the relative difficulty of the problem. Fall 2005 homework copying vs. problem difficulty: A correlation of r = .10 +/- .13, p <.5 is observed between the fraction of students that copy a problem and the relative difficulty of the problem. Correlational errors were calculated using a bootstrap technique [146].

In 2003, we found that repetitive (>30%) copiers attempted a much smaller fraction of practice problems posted prior to an examination. Similarly, the Fall 2005 repetitive copying groups attempt significantly fewer practice problems than students who copy < 30%. For each 2005 group, the fraction of problems attempted declined during the semester (Figure 2-15), in contrast to the Fall 2003 data, where only the repetitive copiers attempted fewer practice problems with each successive exam. The falloff over the term was so severe that the > 50% copiers attempted no practice problems prior to the final exam in 2005. The decrease in the fraction of practice problems done with time by everybody is a marked difference between 2003 and 2005. This may result from the larger number of required activities in TEAL, or from the students feeling that they have more attractive means of reviewing for the final exam, or from the fact that the final exam is weighted less heavily in the overall grade.

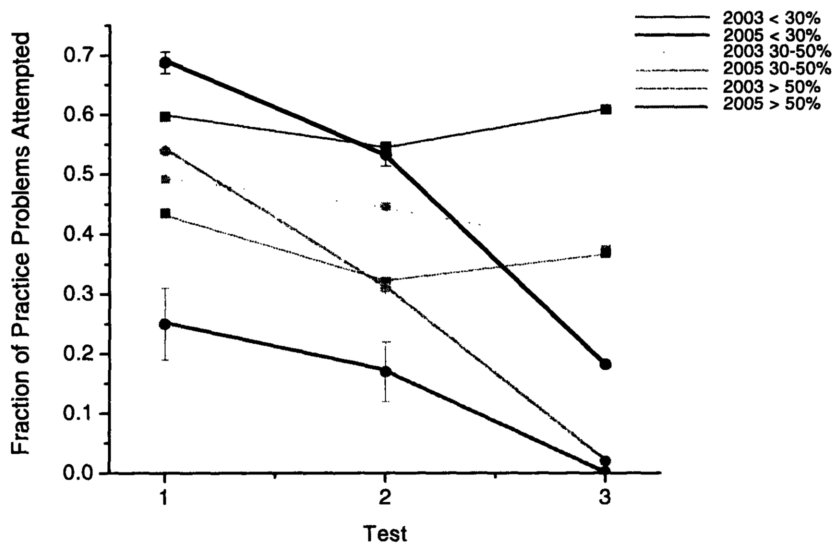


Figure 2-15: Fall 2003 and Fall 2005 exam practice problem fraction vs. exam. For the 2005 class, we observe that all copying groups exam preparation decreases strongly with time.

Next we observe the performance of repetitive copiers on other routine course elements, such as written homework, in-class quizzes, and in-class problem solving. For the Fall 2003 class, only data concerning written homework was available. All other routine performance measures were instituted with the Fall 2005 class. The first routine course element is written homework. During both Fall 2003 and Fall 2005, one written homework assignment was due each week; each assignment was graded on a scale of 0-10, with 10 being 100% complete and correct. We observe no significant differences between the written homework performance of copiers vs. non-copiers for both classes. This probably reflects the ease with which written homework is copied vs. the difficulty with which it is detected (i.e. not at all).

The remaining routine performance measures were only available for the Fall 2005 class. Homework copying is also related to a student's performance on in-class quizzes(Figure 2-16). These quizzes were short tests, 1 problem only, administered once a week, and covered material from the class during that week. Both groups of repetitive copiers performed significantly lower on in-class quizzes as compared to students who copied < 30% of electronic homework, p-value < .0001.

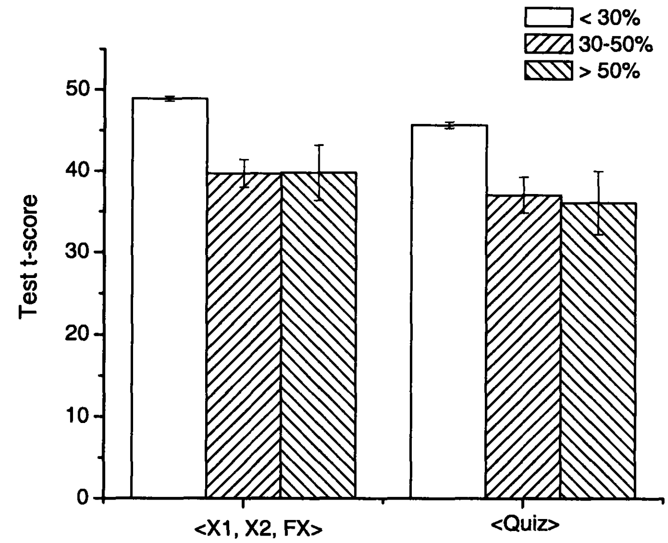


Figure 2-16: Fall 2005 in-class quiz performance and homework copying. The difference between >30% copiers and repetitive copiers for quiz performance and average test performance is significant at p < .0001.

In-Class problem solving sessions were also conducted once a week. Students who copied > 50% of homework were awarded significantly less in-class problem solving credit than students who copied < 30% (p < .0001) and students who copied 30-50% (p-value < .0001), Figure 2-17. We observe no significant differences between students who copied < 30% of homework and students who copied 30-50% (p-value < .8)

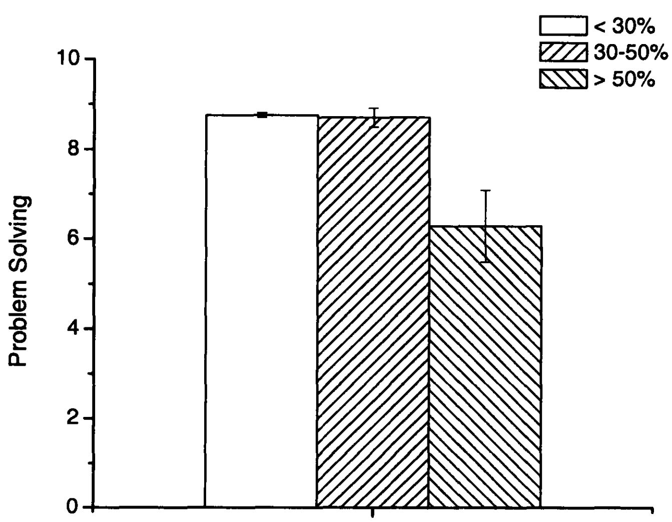
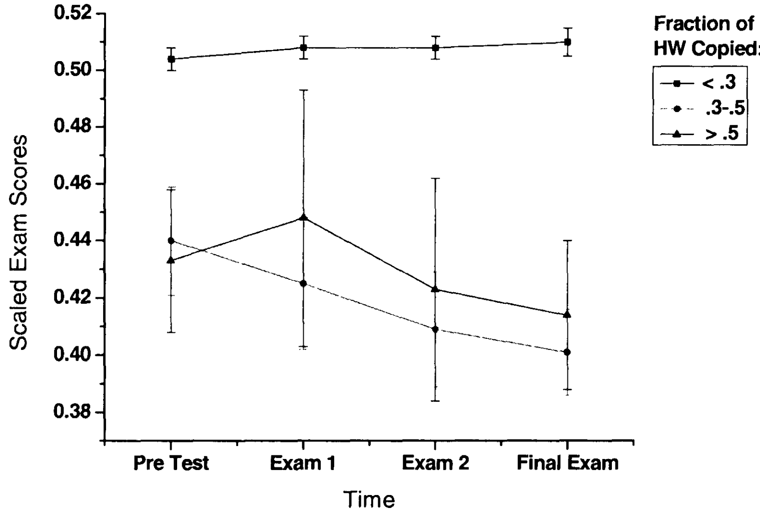
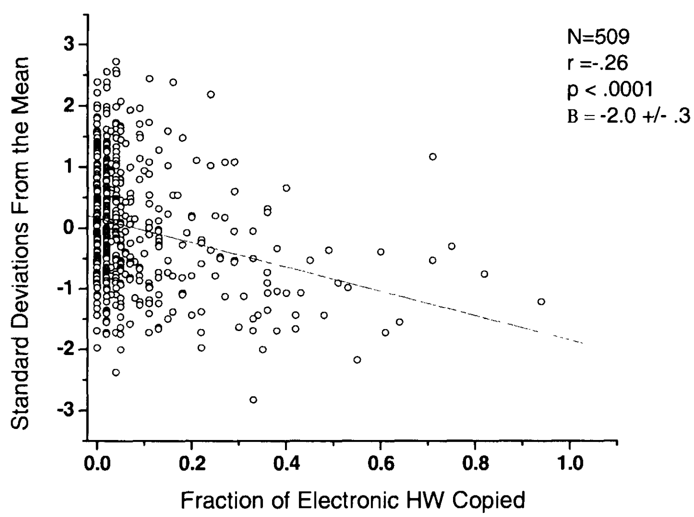


Figure 2-17: Fall 2005 in-class problem solving and homework copying.

Consequences: Fall 2005. The most significant consequence of repeated homework copying is severely declining performance on major tests as the semester progresses. Four primary performance measurements were administered during the Fall 2005 semester: A diagnostic Mechanics Baseline Test, 2 "mid-term" exams, and a course final exam. At the start of the Fall 2003 semester, all students entered the class with the same knowledge base as measured by the diagnostic Mechanics Baseline Test; however, we observe a significant difference between the <MBT pre-scores> of the repetitive copiers and of all other students in 2005. Repetitive homework copiers began the semester .6 standard deviations below all other students as measured by the diagnostic MBT t-score. As in Fall 2003, repetitive homework copiers also scored lower on each successive test as the semester progressed(Figure 2-18, A). On the 8.01 final exam, students who copied 30-50% of their electronic homework scored 1 +/- .2 standard deviations below the main group of students and students who copied more than 50% of their electronic homework scored .8 +/- .2 standard deviations below them. We observe a Pearson correlation coefficient of $r = -.26$, $p < .0001$ for the relationship between a student's final exam t-score and the fraction of electronic homework problems copied (Figure 2-18, B).

Just as in the Fall 2003 data, students who repeatedly copy their electronic homework have a much higher attrition rate than students who do not (Figure 2-18, C). While only 3% of non-copiers failed Newtonian Mechanics, 11% (N=3) of students who copied between 30-50% of their electronic homework and 26% (N=3) of students who copied more than 50% of their homework failed to matriculate to Electricity and Magnetism (Figure 2-18, C). The 7.5% of the class population comprised of repetitive homework copiers accounted for over 50% of all class failures and 25% of all drops.


Fraction of HW Copied:
< .3
.3-.5
> .5
Scaled Exam Scores
Pre Test
Exam 1
Exam 2
Final Exam
Time


N=509
r =-.26
p < .0001
B = -2.0 +/- .3
Standard Deviations From the Mean
Fraction of Electronic HW Copied

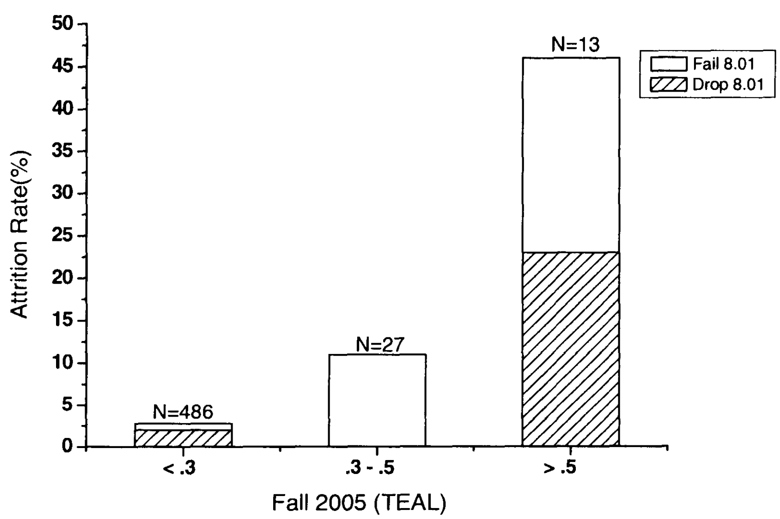

Fail 8.01
Drop 8.01
N=486
N=27
N=13
Attrition Rate(%)
< .3
.3 - .5
> .5
Fall 2005 (TEAL)

Figure 2-18: Fall 2005 consequences of electronic homework copying. (A) Exam performance using scaled t-scores for each group of students shows a decline associated with electronic homework copying. The calculated error for each exam is the standard error of the mean. (B) Final exam performance vs. fraction of electronic homework problems copied. The fraction of homework problems copied is a significant variable when predicting a student's final exam score, Pearson correlation coefficient r = -.26, p < .0001. (C) Attrition rate over the two semester physics sequence for repetitive copiers (.3-.5 and > .5) and all other students (< .3). The listed N above each group of students is the number of students contained in the group.

For both Fall 2003 and Fall 2005 we calculate the learning per electronic problem for each copying group by fitting a slope to their exam performance over time. Table 2-7 and Table 2-8 report the fitted slope and the average fraction of problems copied for each copying group. Students who copied < 30% were further broken down into three groups: Students who copied < 10%, students who copied between 10-20%, and students who copied between 20-30%. For both Fall 2003 and Fall 2005, the only group with a positive slope were students who copied < 10% of their electronic homework.

In order to investigate whether a little copying is detrimental to exam performance, we plot the slope of each copying group against the average fraction of problems copied and fit the slope for each class (Figure 2-19). A summary of relevant statistics from each class is reported in Table 2-9. First, as expected, we observe a negative correlation for both classes. However, copying in general, and more specifically small amounts of copying, were more detrimental to students enrolled in the 2003 lecture recitation class than to students in the 2005 TEAL class. Although we observe a negative slope for the 2005 performance gradient vs. copying, the correlation is not significant with p < .4. And, although the 2005 slope is 50% less than the observed 2003 slope, significance is negated by the large 2005 slope error. We believe that copying seems to have a greater net effect on students in the lecture recitation class environment. This could be, again, because within the lecture environment there are limited learning methods enforced on the student – namely homework was the principal learning vehicle. Within the TEAL environment, students are exposed to many learning activities besides homework, so the copying of small amounts of homework has little net effect on student learning.

	Fall 2003				
	< .1	.1-.2	.2-.3	.3-.5	> .5
Slope	0.0059	-0.0077	-0.0029	-0.013	-0.016
Slope Error (+/-)	0.001	0.003	0.004	0.004	0.004
Average Fraction Copied	0.034	0.142	0.243	0.411	0.666
Error	0.001	0.003	0.005	0.007	0.017

Table 2-7: Fall 2003 Exam t-score slope vs. <Fraction of Problems Copied>.

	Fall 2005				
	< .1	.1-.2	.2-.3	.3-.5	>.5
Slope	0.002	-0.00052	-0.013	-0.013	-0.007
Slope Error (+/-)	0.001	0.0046	0.007	0.007	0.01
Average Fraction Copied	0.025	0.134	0.243	0.375	0.673
Error	0.001	0.003	0.031	0.009	0.031

Table 2-8: Fall 2005 Exam t-score slope and <Fraction of Problems Copied>

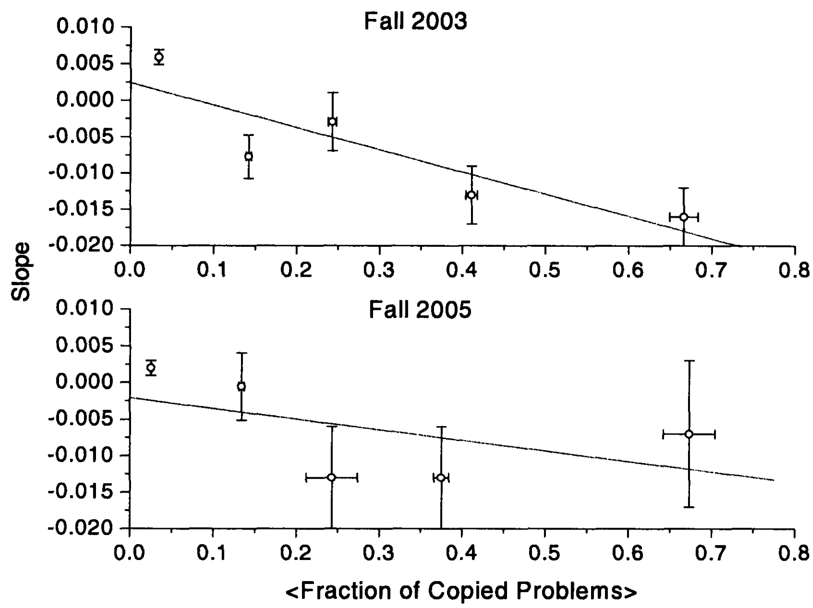


Figure 2-19: Fall 2003 and Fall 2005 Slope vs. <Fraction of Problems Copied>>
The larger error bars result from having fewer students in the groups that copied lots of problems.

	N	r	Confidence	Slope	Error
Fall 2003	5	-0.88 +/- 0.13	p < .05	-0.031	0.009
Fall 2005	5	-0.52 +/- 0.21	p < .4	-0.014	0.013

Table 2-9: Summary Statistics for Slope Analysis

Summary and Discussion.

We have reported patterns and consequences from two Newtonian Mechanics classes: Fall 2003 and Fall 2005. Despite finding conclusive evidence linking several demographic factors and cheating in our literature review (Chapter 1), our data show that demographics play little role in predicting who might be predisposed to copying physics homework. Of ten factors, only gender produced significant results (women copy less, but this may be linked to other demographic factors such as ethnicity and major). While a link between a student's prior physics experience and/or math skill and physics homework copying seems reasonable based on the idea that less skillful students have a harder time keeping up with the pace and are therefore more prone to save time by copying, our results do not bear this out.

Several of the homework copying patterns observed in 2003 are again observed in 2005. These include the increase in copying over the semester, the smaller fraction of practice problems attempted prior to exams by repetitive copiers, the higher fraction of late interactions logged by repetitive copiers, and the greater tendency of the repetitive copiers to put off making progress their homework during the assignment cycle, including a several times larger fraction of late submissions. These patterns of student behavior are all consistent with the notion that students copy homework in response to time pressure, and that poorer time management skills correlate with more copying.

However, not all of the patterns observed in the 2003 class were also observed in the 2005 class. Unlike 2003, there was no significant correlation between the difficulty of a problem and the fraction of students that copied it. . (However, 26% of these same students reported in a self-reported cheating survey that the problem difficulty combined with time constraints was their leading reason for copying.) A further difference was that the 2003 main group of students (<30% copiers) worked their homework problems at a much more distributed rate of effort than the 2005 main group of students.

We observe similarly adverse consequences associated with homework copying during the Fall 2005 class. We have again demonstrated a strong correlation between homework copying and poor test performance. Together with the fact that the copying precedes the poor test performance, this furthers our argument that copying *causes* the observed correlation with decreasing test performance. Two different ways of analyses done on two classes, one taught in lecture-recitation format and the other using a studio physics format gave the same result: students who copy more electronic homework perform progressively worse on examinations over the term such that a 100% copier would do over 2 standard deviations worse on the final examination than if he had done all of the electronic homework.

2.3 Algorithms Predict 8.01 Final Exam and 8.02 Course Performance

In this section, two prediction algorithms are presented. Both algorithms are motivated by the desire to identify and provide a remedial course of action for students who are at risk of poor performance in either 8.01 or 8.02. First, an 8.01 early-term algorithm is presented that will allow the identification, and remedial treatment, of students who are at risk of 8.01 failure with sufficient time remaining in the semester. Next, 8.02 prediction algorithms are presented in order to identify students who may have passed 8.01, but historically perform below average during the follow-on course, 8.02, Electricity and Magnetism. All algorithms are computed using a stepwise multi-regression involving 8.01 course elements.

8.01 Early-Term Final Exam Prediction. In part motivated by a desire to provide special tutoring for at risk students, we have found a prediction algorithm to identify, early in the term, students who are at risk for poor final examination performance. We performed a stepwise multi-regression using the Fall 2003 amount of homework copying (C), average skill of students determined from the online homework tutor (S), diagnostic MBT score (D), and Exam 1 score (X1), written homework grade to that point (H) – each variable being normalized by its standard deviation (z-score). The result is:

E1. Final Exam Grade = - 0.36 C + 0.21 X1 + 0.19 S + 0.17 D

where student skill is measured using the algorithm in [8], and written homework was insignificant. Table 2-10 lists the variables used in the multi-regression, the standardized correlation coefficient (β), the t score of the variable, and the confidence interval of the variable.
Overall, this model accounts for 53.3% of variance when predicting a Fall 2003 student's Final Exam score, adjusted $R^2 = .53 \pm .06$, $p < .0001$. Within this model, electronic homework copying accounts for the most variance, followed by a student's Exam 1 performance.

Variable	Key	β	t	p-value
H	Written Homework	0.011	0.258	0.797
X1	**Exam 1**	**0.211**	**4.685**	**0.0001**
S	**Student Skill**	**0.186**	**4.195**	**0.0001**
C	**Copying**	**-0.362**	**-8.055**	**0.0001**
D	**MBT Diagnostic Test**	**0.174**	**3.867**	**0.0001**

Table 2-10: Fall 2003 Early Term Prediction of 8.01 Final Exam Score

Using the Fall 2005 data set, we perform a similar multi-regression with results reported in Table 2-11 and Eq.2.

E2. Final Exam Grade = 0.39 X1 + 0.22 D - 0.15 C + 0.15 S

Written homework performance is again an insignificant predictor of final exam performance. Overall, this model accounts for 40.1% of the variance when predicting a Fall 2005 student's final exam score, adjusted $R^2 = .40 +/- .08$, $p < .0001$. Within this model, Exam 1 accounts for much more variance than the Fall 2003 model, and for almost twice the variance of the next most significant variable, the diagnostic MBT score. One reason for this change may be attributed to the change in the magnitude of the homework copying between Fall 2003 and Fall 2005. 14% of all Fall 2003 problems were copied, whereas only 7.9% of all completed problems were copied during the Fall 2005 class, a 56% reduction between the two classes.

Variable	Key	β	t	p-value
H	Written Homework	0.027	0.631	0.528
X1	Exam 1	0.388	9.968	0.0001
S	Student Skill	0.147	3.81	0.0001
C	Copying	-0.152	-3.968	0.0001
D	MBT Diagnostic Test	0.223	2.125	0.0001

Table 2-11: Fall 2005 Early Term Prediction of 8.01 Final Exam Score

8.02 Performance Predictions. In this section we present algorithms that predict performance on the 8.02 Final Exam and a student's 8.02 Final Grade. All algorithms rely on comprehensive data from the 8.01 semester. Data was obtained from the 8.01 Fall 2003 Newtonian Mechanics course and the follow-on 8.02 Electricity and Magnetism course taught in the Spring, 2004. Of the 428 students that took 8.01 in Fall 2003, 8.02 final exam scores were available for only 266 of these students. Most of the other students enrolled in 8.02x, an experimental based electricity course that did not have a course final exam. The remaining students did not matriculate into 8.02 because they failed 8.01. There exists a bias in our sample because 50% of the students copying > 50% of their 8.01 homework were removed due to 8.01 failure. For the 8.02 final grade analysis, the bias is smaller because data was available for ~400 students, with only the students who failed 8.01 and who have not yet completed 8.02 missing. These 25 students copied an average 31% of their 8.01 electronic homework.

For both algorithms, the following 8.01 variables were considered: HW Copying, MasteringPhysics Skill, Exam 1, Exam 2, Exam 3, MasteringPhysics cumulative grade, written homework cumulative grade, and the 8.01 Total Final Exam score. The MBT diagnostic score was not used because it was not a significant predictor variable. The Total Final Exam score was a combination of a students final exam score and their MBT Post score. Analysis was conducted using both the individual final exam score and MBT Post score vs. the Total Final Exam score. The MBT Post score as an individual variable was insignificant and using the 8.01 Total Final

Exam Score variable resulted in a slightly higher correlation. Therefore, the student's 8.01 Total Final Exam score was used. A stepwise multi-regression was performed using the above 8.01 variables vs. the student's 8.02 Final Exam score. From the above variables, only 4 variables were significant predictors: HW Copying (C), Exam 3 (X3) , MasteringPhysics cumulative grade (M), and the 8.01 Total Final Exam score (FX). Eq. 3 and Table 2-12 summarizes the analyzed variables. This model has an adjusted $R^2 = .283$ +/- .06, accounting for 28.3% of the variance in a students 8.02 Final Exam score. Of the four significant variables, two originate from a student's interactions with MasteringPhysics.

Eq. 3: 8.02 FE = .31 FX + .21 X3 - .14 C + .11 M

Variable	Key	β	t	p-value
C	Copying	-0.14	-2.526	0.0001
M	MasteringPhysics Grade	0.109	1.996	0.047
X3	Exam 3	0.205	3.239	0.001
FX	Total Final Exam Score	0.309	4.892	0.0001

Table 2-12: Spring 2004 8.02 Final Exam Prediction

A stepwise multi-regression was also performed using the above 8.01 variables vs. a student's 8.02 Final Grade. Again, only 4 variables were significant predictors: HW Copying (C), Exam 3 (X3) , MasteringPhysics cumulative grade (M), and the 8.01 Total Grade (TG). Eq. 4 and Table 2-13 summarizes the analyzed variables. This model has an adjusted $R^2 = .386$ +/- .07, accounting for 38.6% of the variance in a student's 8.02 Final Grade. Student interactions with MasteringPhysics account for ~50% of the model's variance.

Eq. 4: 8.02 FE = .34 TG + .23 M + .15 X3 - .14 C

Variable	Key	β	t	p-value
C	Copying	-0.137	-2.327	0.005
MP	MasteringPhysics Grade	0.237	5.129	0.0001
X3	Exam 3	0.158	2.588	0.001
FX	8.01 Final Exam Score	0.337	5.048	0.0001

Table 2-13: Spring 2004 8.02 Final Grade Prediction

3 Self-Reported Cheating by MIT Freshmen

This chapter will summarize the results of a self-reported cheating survey administered to MIT Freshmen (MITF) during the Spring 2006 8.02 class (N = 268) at MIT concerning copying by students during the previous semester's 8.01 course. These results are compared with three benchmarks: A sample of undergraduates from over 60 U.S. colleges and universities, a sample of MIT Freshman from AY 1990-1991 [82], and against levels of detected homework copying from the Fall 2005 8.01 Newtonian Mechanics class. Each comparison provides unique insights:

- Comparing self-reported homework copying against detected homework copying will test the accuracy of the self-reported survey as an instrument to measure copying behavior.
- Comparison against the national sample gives faculty and students an idea how MIT Freshman report and view cheating relative to students nationwide.
- Comparison against MIT Freshman data from AY 1990-1991 provides a longitudinal perspective within the institution.

Sample.

Our sample consists of students from the MIT Spring 2006 8.02 Electricity and Magnetism class (Total N = 653). This course contained 8 sections; enrollment in each section varied between 80 and 110 students. From these six sections, a total of 268 undergraduates completed the survey a 41% course participation rate. No demographic information (e.g. age, sex, or ethnicity) was recorded during the survey. Although the sample is not indicative of the MIT student population, we believe it is generally representative of the MIT Freshman population(26.8% of the Freshman population, N = 1001) except that better prepared students may advance place the course or take a more advanced version of E&M.

Survey.

To achieve our three objectives, the survey had to have questions drawn from the national survey, questions comparable with the MIT '90-'91 survey, and questions that would allow direct comparison with our copying data from the previous semester.

The survey instrument for our analysis was based on a national survey administered to over 50,000 collegiate students between 2002-2004 through cooperation with the Center for Academic Integrity.

To get a good comparison with these national results, 19 (of the 55) survey questions from the national survey were included verbatim in our survey. We queried students on how often they believed three forms of cheating occurred on the MIT campus, their own frequency of 8 forms of cheating over the past year, and asked students to judge the seriousness of each of these 8 forms of cheating.

A search for time variation at MIT is based on comparisons with data contained in the report "Undergraduate Academic Dishonesty at MIT" [82]. We picked questions from the national survey that were basically the same as the MIT survey.

Several additional questions exclusive to our survey were added as well. The first additional question facilitates a comparison against detected electronic homework copying from the previous semester's 8.01 Newtonian Mechanics class. This additional question asked students to self-report the fraction of electronic 8.01 homework problems that were copied. Also, we asked students why (or why not) they copied (or did not copy) 8.01 homework problems. The survey included 4 free response questions asking students to explain *how* they (or other students) copied 8.01 electronic and written homework. Finally, in an attempt to assess correlates with cheating, 12 questions addressing correlates of cheating were also asked: 8.01 section, prospective major, high school science homework copying, individual course goals (e.g. learning physics vs. just getting a good grade), etc. See Appendix F for a complete copy of the survey and Appendix G for the survey results.

Procedures.

During the middle of the Spring 2006 term, a self-reported cheating survey was administered to seven of the eight MIT 8.02 sections (1 section denied participation). Students were given a short introduction to the purposes of the survey, and were assured that the survey was both anonymous and voluntary. Students were given 15-20 minutes to complete the survey, after which student T/A's collected the surveys and returned them to the researcher. Surveys were processed and scored using an electronic scanner and scoring software.

Analysis.

National survey results were derived from an external University of Oklahoma report [156] that quoted the detailed (i.e. to each question) national survey results (N = 51,611 U.S. undergraduates) at that time for comparison purposes. The national survey administrator, Don McCabe, provided an Australian publication [155] that reported the most recent cumulative U.S. national survey results. Unfortunately, these published results contained only aggregate totals for the frequency of each type of cheating behavior. However, the aggregate totals for each form of cheating from McCabe's Australian publication were within the calculated error of the national averages reported in the University of Oklahoma report (+/- 4% based on national n = 20,000). For over half of the forms of cheating queried, the aggregate totals were exactly the sum of the individual categories listed in the OU survey. Therefore, for purposes of the most detailed comparison between MIT Freshman (MITF) and national students (NS), the national survey results contained in the OU internal report document were utilized. The aggregate totals were also compared with the aggregates listed in [155].

To ensure accurate longitudinal comparisons of MITF, only the freshman data from the Lipson survey were analyzed. This was possible because Lipson's original survey of N=444, included class information, allowing us to separately analyze the N_f= 111 freshmen.

Longitudinal comparisons included how frequently students engaged in 8 cheating behaviors and how seriously they view these 8 cheating behaviors. Unfortunately, the national survey questions and categories did not exactly match the Lipson questions and categories, however, several categories could be combined to facilitate comparison.

The Lipson study quantified cheating frequencies using the categories never, once/twice, occasionally, and frequently; whereas our survey (and the national survey), quantified cheating frequencies using never, once, and more than once. Because of the assymetric categories, only the fraction of students who reported they had never cheated or had cheating for each behavior are compared. The Lipson study quantified the seriousness of a cheating behavior using the categories not cheating, trivial cheating, or serious cheating; whereas our survey and the national survey used the categories not cheating, trivial cheating, moderate cheating, and serious cheating. Our survey data were combined to not cheating, trivial cheating, and serious cheating (moderate cheating + serious cheating) to facilitate comparison with the Lipson data. Because the national survey questions were used verbatim in our survey, they were not worded exactly the same as the Lipson questions. Table 3-1 shows the matched questions from each survey.

1992 Lipson Survey	2006 Survey
Collaborating on homework answers when prohibited	Working on an assignment with others when the instructor asked for individual work
Copying homework that will be graded	Turning in a homework assignment partly copied from another student's work, a "bible" a website, etc
Collaborating on approach to homework when prohibited	Receiving unpermitted help on an assignment
Misrepresenting or fudging data in a lab report or research paper	Fabricating or falsifying lab data
Study copy of previously given exam when prohibited	Getting Q/A from someone who took the test
Copying from another student during an exam	Copying from another student during a test or exam without his or her knowing it
Permitting another student to copy exam answers	Helping someone else cheat on a test
Submitting another person's paper or lab report as one's own	Turning in work done by someone else

Table 3-1: Matched survey questions for analysis of 1992 MITF and 2006 MITF

3.1 Survey Results vs. a Sample of National Students

We have divided the questions common to both our survey and the national survey into two major categories: perceptions of others' cheating and reports of self cheating. The latter category is further subdivided into three subcategories: cheating on tests, plagiarism, and unauthorized collaboration.

The results for each question are displayed using bars to represent the fraction of given answers in each category (Figures 3-1,2,3). Errors for each category were computed using a binomial distribution with a 95% confidence level [156]. The much smaller error on the national data reflects the significantly larger sample size of the national study (~20,000 students vs. 268 students). The data are summarized for each question by the following scheme: the five categories are given increasing integer values 0 to 4, and the mean and error are calculated in units of one "category width". These are displayed as horizontal bars on each figure, with the width of the bar representing the standard deviation of the mean.

The first three survey questions concerned perceptions of how frequently plagiarism, test cheating, and inappropriate collaboration occur on campus. Figures 3-1,2,3 show the results of each question vs. the national averages. MITF perceive that significantly lower rates of "Plagiarism on written assignments" and "Cheating during tests/exams" occur at MIT than do college students nationally, by about an entire category width (.90 +/-.08 and .93 +/-.07 categories, respectively.) Although their perception of the rate of "Inappropriate sharing in group assignments" is less than students nationwide, it is only by 0.23 +/-.07 categories. The fact that MITF reported *relatively* more collaboration than test cheating or plagiarism may well reflect two facts: MIT encourages students to work together and it has an above average work load.

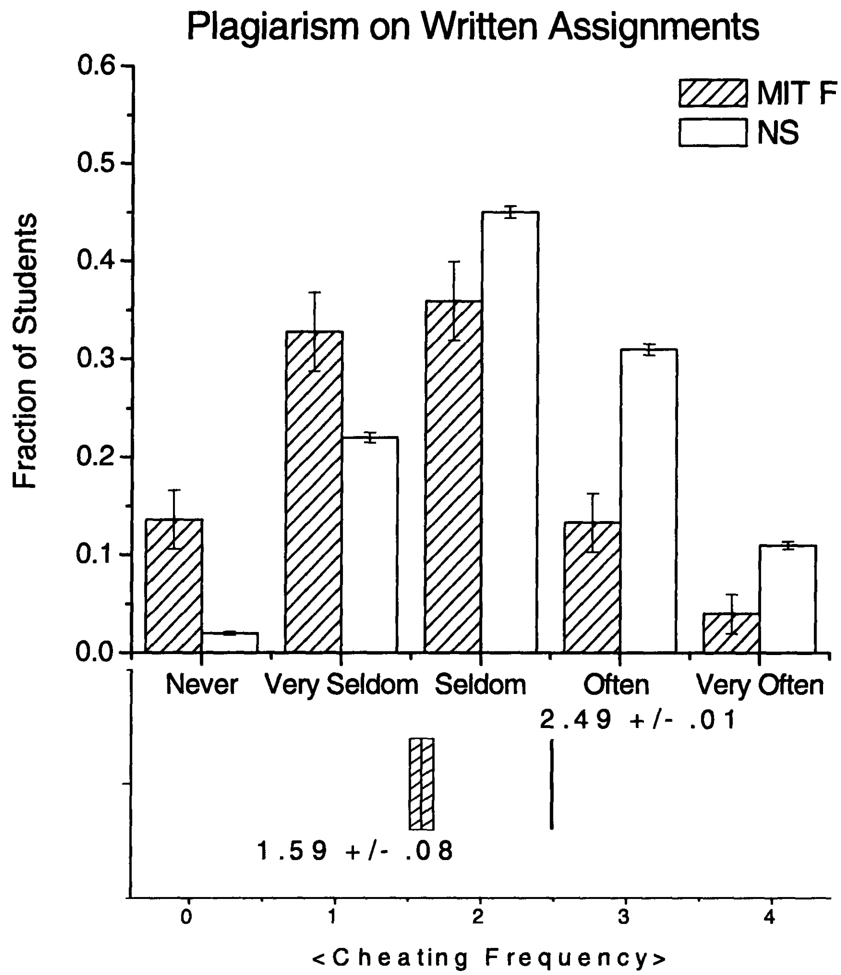


Figure 3-1: MITF vs. NS perception of the campus prevalence of Plagiarism on Written Assignments. MITF believe significantly less plagiarism occurs on campus than nationally by .90 +/- .08 categories.

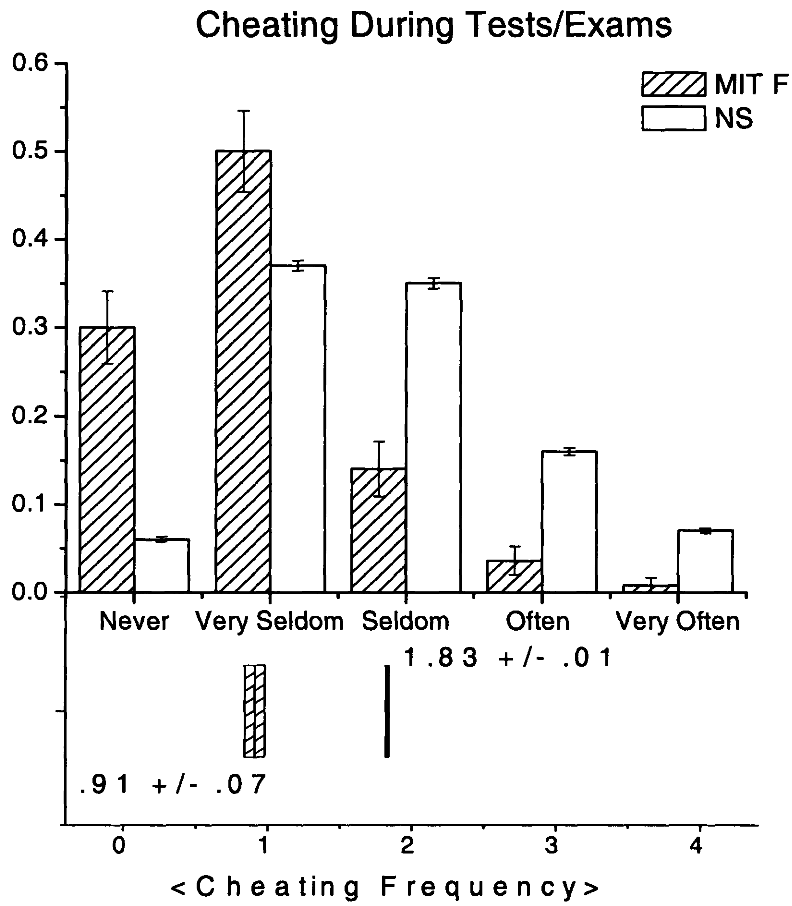


Figure 3-2: MITF vs. NS perception of the campus prevalence of Cheating during tests/exams. MITF believe significantly less test cheating occurs on campus than nationally by .93 +/- .07 categories.

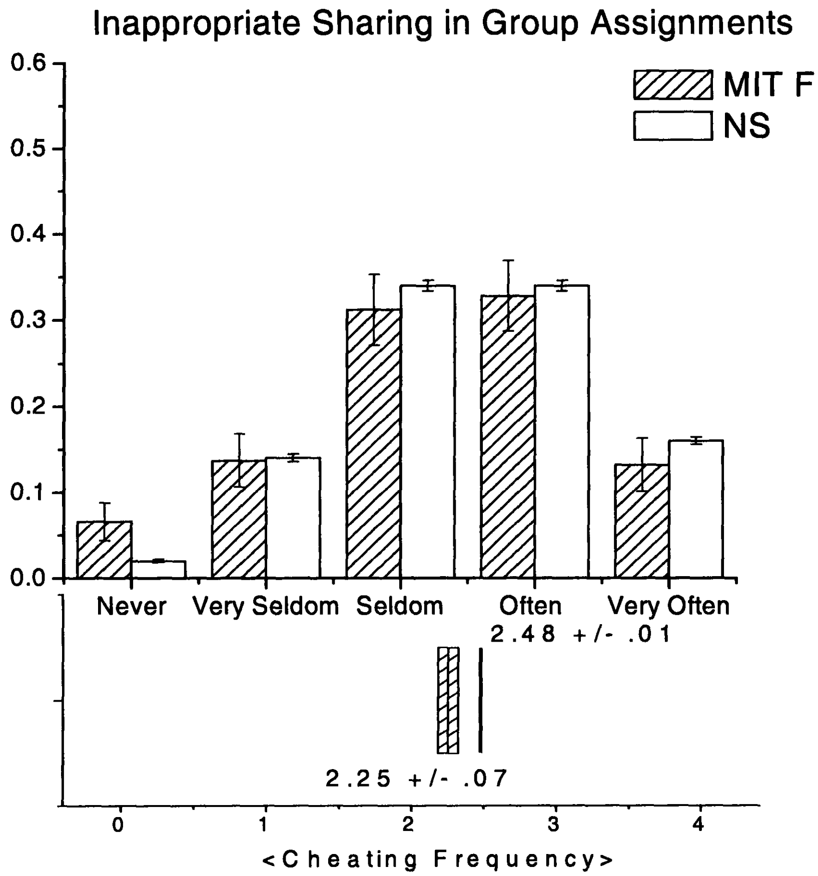


Figure 3-3: MITF vs. NS perception of the campus prevalence of Inappropriate Sharing in Group Assignments. Although MITF believe that less inappropriate sharing occurs on the MIT campus than nationally, by 0.21+/-0.07 categories, a very significant difference, but one much smaller than for test cheating or plagiarism.

The remaining national survey comparisons consist of 8 questions asking students to self-report frequencies of their own cheating behavior. For each of the 8 forms of cheating, the survey asked students to self-report on a scale of never, once, and more than once. The data are summarized for each cheating form by using the following scheme to estimate the occurances per student: the three categories are given increasing integer values 0 to 3, and an average cheating frequency is calculated for both groups of students. (Obviously, the first two categories correspond to 0 and 1, respectively; we chose 3 for "more than once" because we know it is greater than or equal to 2, but not necessarily that it is greater than 3.) These are displayed as horizontal bars on Figure 3-4, with the width of the bar representing the standard deviation of the mean. For each corresponding form of cheating, students were also asked to report how serious they believed that form of cheating to be, using the scale not serious, trivial, moderate, and serious. Each group's cheating tolerance is summarized by the following scheme: the four categories are given increasing integer values 0 to 3, and an average tolerance score is calculated for both groups of students. These are displayed as horizontal bars on Figure 3-5, with the width of the bar representing the standard deviation of the mean.

Average Cheating Frequency For Each Form of Cheating

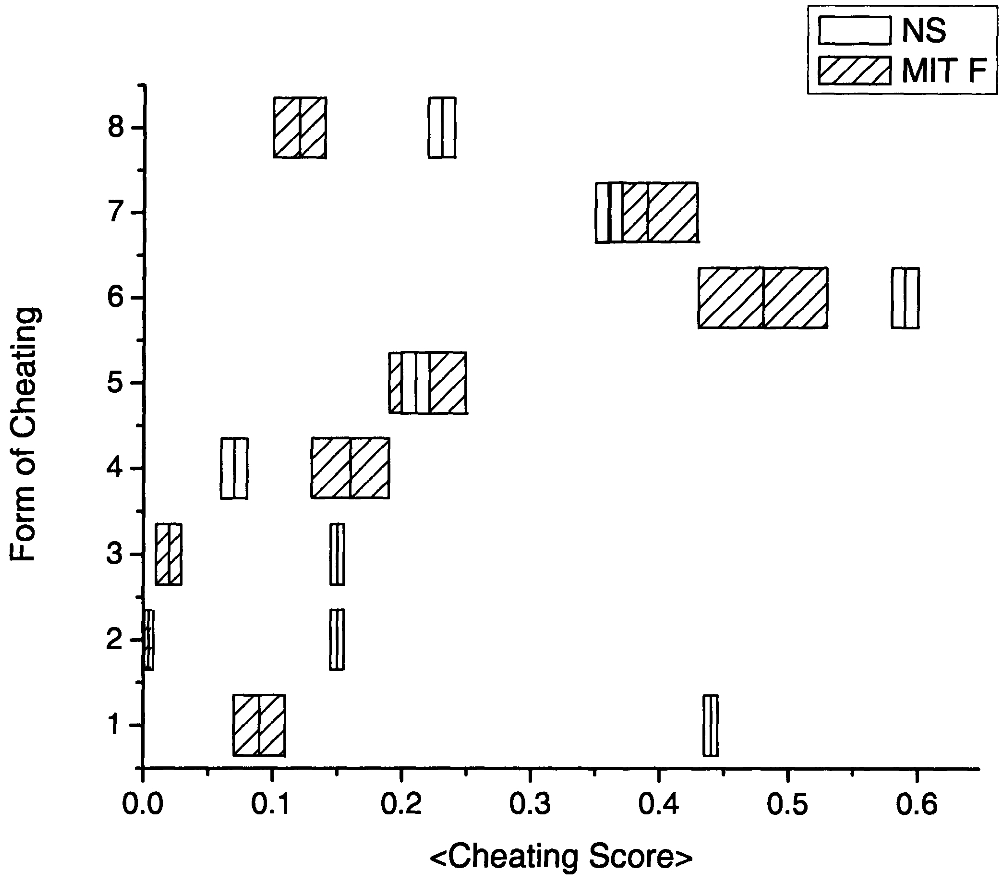


Figure 3-4: Self-Reported Cheating of MITF and NS. MITF report an average .08 +/- .02 less per form of cheating than NS, even though they are significantly more tolerant of Turning In Work Done By Someone Else.

Key:

8 – Using a false excuse to obtain extension to a due date

7 – Receiving unpermitted help on an assignment

6 – Working on an assignment w/ others when the instructor asked for individual work

5 – Fabricating or falsifying lab data

4 – Turning in work done by someone else

3 – Copying on a test from someone else w/o their knowing

2 – Helping someone else cheat on a test

1 – Getting Q/A from someone else who took the test

Average Tolerance For Each Form of Cheating

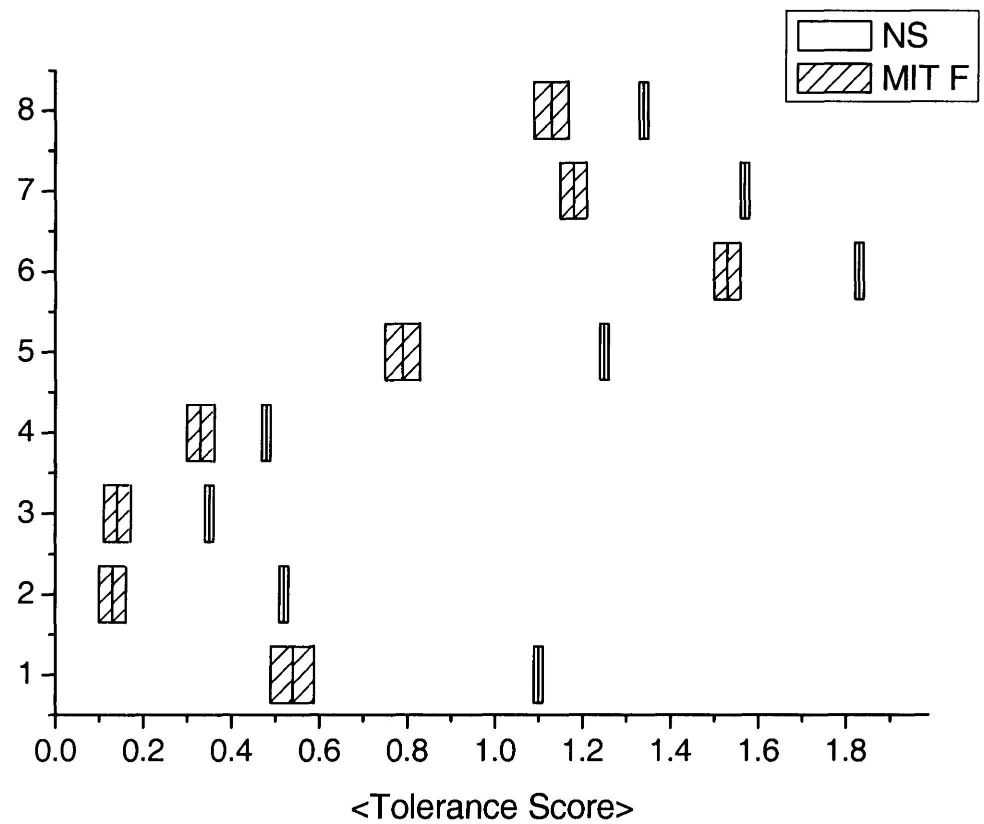


Figure 3-5: Self-Reported Tolerance of Cheating for MITF and NS. MITF report an average .33 +/- .02 less tolerance for each form of cheating than NS.

Key:
8 – Using a false excuse to obtain extension to a due date
7 – Receiving unpermitted help on an assignment
6 – Working on an assignment w/ others when the instructor asked for individual work
5 – Fabricating or falsifying lab data
4 – Turning in work done by someone else
3 – Copying from someone else w/o their knowing
2 – Helping someone else cheat on a test
1 – Getting Q/A from someone else who took the test

	<Cheating Frequency>		<Tolerance Score>	
	MITF	NS	MITF	NS
Getting Q/A from someone else	.09 +/- .03	.44 +/- .01	.54 +/- .06	1.1 +/- .01
Helping someone else cheat on a test	.004 +/- .001	.15 +/- .01	.13 +/- .04	.52 +/- .01
Copying from someone else w/o their knowing	.02 +/- .01	.15 +/- .01	.14 +/- .03	.35 +/- .01
Turning in work done by someone else	.16 +/- .01	.07 +/- .01	.33 +/- .05	.48 +/- .01
Fabricating or falsifying lab data	.22 +/- .05	.20 +/- .01	.79 +/- .06	1.25 +/- .01
Working on an assignment w/others...	.48 +/- .06	.59 +/- .01	1.53 +/- .06	1.83 +/- .01
Receiving unpermitted help on an assignment	.39 +/- .05	.36 +/- .01	1.18 +/- .07	1.57 +/- .01
Using a false excuse to obtain extension	.12 +/- .03	.23 +/- .01	1.13 +/- .06	1.34 +/- .01

Table 3-2: Average cheating frequency and cheating tolerance scores for each form of cheating.

MITF reported less cheating on tests and less tolerance for such cheating than the NS by large factors, typically between 3 and 10. Three questions addressed test cheating: "Getting questions/answers from someone else who took the test," "Helping someone cheat on a test", and "Copying during a test without the other person knowing" (Fig 3-4, 1,2,3). For each of these test cheating questions, MITF report far less history of engaging in each behavior than NS in general. MITF (NS) give responses other than "never" to these three questions only 6(30)%, 1(11)%, and 2(11)% of the time. For each of these test cheating questions, refer to Table 3-2 for specific average cheating and tolerance scores for each form of test cheating.

MITF report all forms of test cheating at only 15% of the national average. MITF also believe that each type of test cheating behavior is several times more serious than NS. For helping another cheat or copying on a test respectively, only 9(26)% and 3(13)% of MITF (NS) regarded this action as other than "serious." MITF (NS) reported an average tolerance of .13 +/- .04 (.52 +/- .01) for helping someone cheat and .14 +/- .03 (.35 +/- .01) for copying on a test. Hence MITF seem about three times less tolerant of test cheating than NS. MITF (NS) reported an average tolerance of .54 +/- .06 (1.1 +/- .01) for getting Q/A from someone else who took the test, ~2x less tolerant than NS. However, they were ~5x more tolerant of getting Q/A compared with their own tolerance of helping someone else cheat or copying on a test. This tolerance may reflect the fact that, at MIT, there is no widespread expectation that students not talk about the test afterwards, even to students who have not taken it. Indeed, professors regularly make allowances for this by giving their afternoon section a different quiz than their morning section.

Two questions addressed unauthorized collaboration: "Working on an assignment with others when the instructor asked for individual work" and "Receiving unpermitted help on an assignment" (Fig. 3-4, 4,5). For both questions, MITF and NS report a significant occurrence of such behavior - only 48(55)% and 67(70)% MITF (NS) reported they had "never" engaged in these two forms of cheating. For each of these unauthorized collaboration questions, MITF (NS) reported an average cheating score of .48 +/- .06 (.59 +/- .01) and .39 +/- .05 (.36 +/- .01).

Overall, we can conclude that MITF engage in similar levels of unauthorized collaboration as do NS. However, MITF believe that both forms of unauthorized collaboration are more serious than NS. MITF (NS) reported an average tolerance of 1.53 +/- .06 (1.83 +/- .01) for working with others and 1.13 +/- .06 (1.34 +/- .01) for receiving unpermitted help. Therefore, MITF are about 20% less tolerant of unauthorized collaboration than NS.

Two questions addressed plagiarism: "Turning in work done by someone else" and "Fabricating or falsifying lab data" (Fig. 3-4, 6,7). For each of these plagiarism questions, MITF (NS) reported an average cheating frequency of .16 +/- .01 (.07 +/- .01) and .22 +/- .05 (.20 +/- .01). MITF report twice as much "Turning in work done by someone else" than NS. MITF report similar levels of data fabrication as NS. MITF believe that both forms of plagiarism are more serious than NS. MITF (NS) reported an average tolerance of .33 +/- .05 (.48 +/- .01) for turning in work done by someone else and .79 +/- .06 (1.25 +/- .01) for fabrication of lab data. Therefore, MITF are about 30% less tolerant of these two forms of plagiarism than NS. The final question asked if students had ever using a false excuse to obtain an extension to a due date. MITF report far less history of using a false excuse than NS. MITF (NS) reported an average cheating score of .12 +/- .03 (.23 +/- .01), thus MITF report using a false excuse at about 50% of the national average. MITF also are slightly less tolerant of this behavior, reporting an average tolerance of 1.13 +/- .06 compared with the national average of 1.34 +/- .01.

Using the Oklahoma detailed data as a surrogate for the national survey (as discussed at the beginning of this chapter), we conclude that MITF report significantly less cheating and are significantly less tolerant of cheating than NS. MITF averaged a final cheating score of .18 +/- .02 for all 8 forms of cheating; NS averaged .28 +/- .01. Thus, MITF reported 36% less cheating than NS. MITF averaged a final tolerance score of .72 +/- .04; NS averaged a final tolerance score of 1.06 +/- .01. Thus, MITF report an average 33% less tolerance of cheating than NS. However, the reported cheating by MITF was mostly localized to a few forms of cheating: Working on an assignment... (30%), Receiving unpermitted help (26%) and Falsifying data... (17%). Each percentage is the fraction of the total reported cheating. If we exclude unauthorized collaboration and falsifying data, the difference is far wider: MITF report more than 50% less cheating than NS and are 45% less tolerant of cheating. While this is fairly encouraging, from the absolute perspective, there is room for improvement: 81% (n = 218) of MITF reported at least one incident of cheating over the last year. 27% (n = 71) of MITF reported 5 or more incidents of cheating over the last year; the average student reported 3.23 +/- .16 cheating incidents.

MITF believe that far less cheating occurs on the MIT campus than do NS. Excluding unauthorized collaboration, MITF believe that approximately one category less cheating occurs at MIT as do NS. This difference is certainly significant, and indicates that MITF regard the MIT campus as a more ethical environment than their national counterparts feel about their own campus's. Within each of three categories of cheating, we can also compare the aggregate totals for each form of cheating compared to NS using the complete 50,000 national student sample from [155]. With respect to the two plagiarism cheating categories, an average 78 +/- 5% of

MITF reported they had never engaged in plagiarism, compared with an average of 76 +/- 1% of NS. An average of 57 +/- 6% of MITF reported never engaging in unauthorized collaboration, compared with 62 +/- 1% of NS. For the most egregious forms of cheating, test cheating, the differences are much more dramatic. Only 6 +/- 3% of MITF ever engaged in test cheating whereas only 21 +/- 1% of NS engaged in test cheating. Although MITF reported similar instances of plagiarism and unauthorized collaboration, the dramatic difference in test cheating underscores the significant differences between the MITF population and students nationally.

3.2 Survey Results vs. 1993 MIT Freshman

We have divided the matched questions (see Table 3-1) from our survey and the Lipson survey into two major categories: reports of self cheating and cheating tolerance. Both of these categories are further subdivided into three subcategories: cheating on tests, plagiarism, and unauthorized collaboration.

Because of the assymetric responses solicited from the surveys, data for reports of self cheating have been categorized as "cheated" or "not cheated". For each subcategory, results are displayed in Figure 3-6 using bars to represent the fraction of students who responded that they had engaged in each cheating subcategory. Each subcategory contains either two or three cheating behaviors; errors for each cheating behavior were calculated using a binomial distribution with a 95% confidence level. The total error for each subcategory was calculated from the square root of the sum of the errors squared.

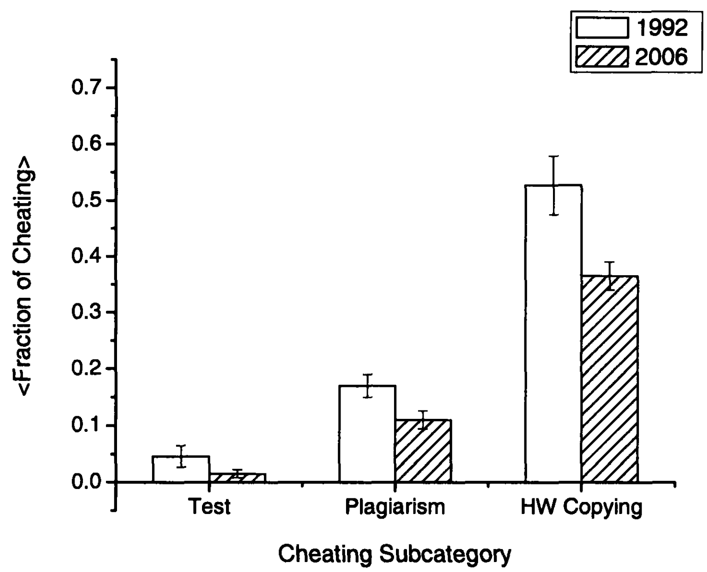


Figure 3-6: S-R cheating of 1992 MITF and 2006 MITF. 2006 MITF report significantly less cheating than 1992 MITF.

For each form of cheating queried, students were also asked how serious they believed that form of cheating to be. Cheating tolerance was measured using the response variables "not cheating," trivial cheating" and "serious cheating." For each subcategory, results are reported in Table 3-3. Figure 3-7 highlights the average fraction of students that believed each subcategory was serious cheating using bars to represent the fraction of students. Errors for each subcategory were calculated using the same procedure as above with respect to the self-reported cheating frequencies.

	Not Cheating		Trivial Cheating		Serious Cheating	
	1992	2006	1992	2006	1992	2006
Test Cheating	1 +/- 1%	2 +/- 1%	14 +/- 1%	12 +/- 1%	81 +/- 3%	91 +/- 1%
Plagiarism	2 +/- 1%	2 +/- 1%	21 +/- 3%	8 +/- 2%	72 +/- 4%	85 +/- 3%
Homework Copying	10 +/-1%	5 +/- 1%	60 +/- 5%	41 +/- 3%	30 +/- 4%	51 +/- 3%

Table 3-3: Reported average cheating tolerance of test cheating, plagiarism, and homework copying of 1992 MITF and 2006 MITF.

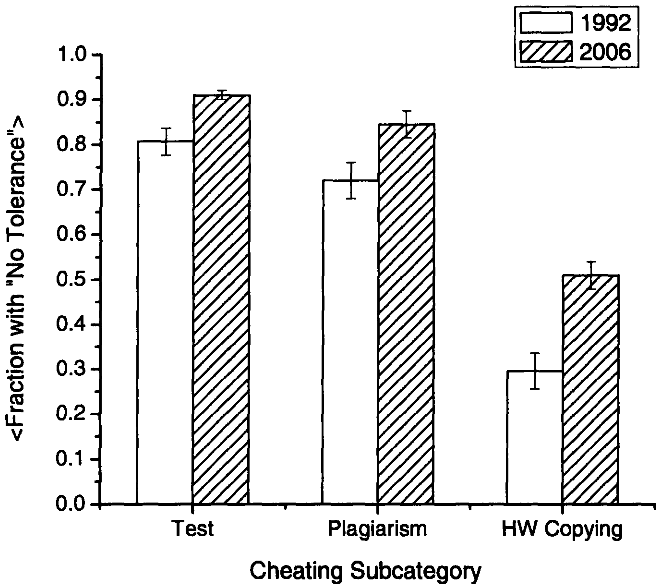


Figure 3-7: 1992 MITF and 2006 MITF that reported no tolerance for test cheating, plagiarism, and homework copying. For each subcategory, more 2006 MITF reported they had no tolerance for cheating than 1992 MITF reported.

When the queried forms of cheating are combined into three subcategories (test, plagiarism, homework) we observe that 2006 MITF report slightly less cheating than 1992 MITF. However, the significance of our results is questionable because of the large errors within each cheating subcategory. With respect to cheating tolerance, we feel strongly that 2006 MITF are less tolerant of cheating than 1992 MITF. The 2006 survey responses included "not cheating," "trivial cheating," "moderate cheating," and "serious cheating." When presented with the same responses as the 1992 MITF, we believe that many of the 2006 students who chose "moderate cheating" would have chosen "serious cheating," further strenthening the difference between 1992 MITF and 2006 MITF. Our results also support earlier conclusions from our review of ~100 studies (Chapter 1) that academic cheating by itself has not increased over the past few decades (although specific forms of cheating, notably unauthorized collaboration, have increased). Especially good news is the small decrease in reported plagiarism. With the advent of term paper websites post-1995, this is a form of cheating we expected to see increase since 1992. We doubt that 2006 MITF have completed fewer papers relative to the 1992 MITF, and our results may be due to greater underreporting by 2006 MITF given the controversial and sensitive nature of term paper plagiarism.

3.3 Survey Results vs. Detected Homework Copying

This section compares the amount and frequency of detected homework copying against the copying reported by students within our survey. We believe this comparison will test the accuracy and suitability of the self-reported survey as an instrument to measure student cheating.

One survey question asked students to self-report the fraction of 8.01 electronic homework problems copied during the previous semester. Categories were none, < 10%, 10-20%, 20-40%, and > 40%. Student copying was detected using two algorithms – each algorithm assigns a probability of copying to each student problem and individual student problems were considered copied when either probability of copying was greater than .75. The first algorithm analyzes the time a student takes to solve a problem relative to the times of all other students who solved the same problem. The second algorithm analyzes a student's interactions, factoring in variables such as when the student solved the problem, when during the term the assignment falls, the past copying history of that student, the difficulty of the problem, and whether the student solved the problem correctly. It is highly unlikely that a student would solve several problems entirely correct with no mistakes, especially when each problem consists of several distinct parts and each part must also be solved correctly the first time (e.g. for a student to solve three problems correctly in consecutive order might require the submission of 15-20 correct responses with no mistakes). In effect, the first algorithm compares a students' interactions with all other students on the same problem while the second algorithm compares a student to their previous interactions and includes relevant background information germaine to the problem solving process.

The self-reported copying fractions are compared against the detected MasteringPhysics homework copying from the same semester in Figure 3-8. 50% less copying was self-reported than was detected (p-value $< 1 \cdot e^{-6}$). Although the differences between self-reported and detected copying for the categories of 10-20%, 20-40%, and > 40% were not statistically significant (p-values were < .33, .20, and .20 respectively), we conclude that about half of those that reported "no copying" are actually copying their homework at a rate less than 10%. Our results are not without limitations. Because our self-reported survey was anonymous, we cannot compare individual self-reported copying rates with the corresponding detected copying rates. Ideally, this scenario would present the most evidence for under-reporting of cheating behaviors. Also, only the detected copying fractions of students who matriculated into the 8.02 were analyzed; this removed the ~4% (n = 24 students) that failed or dropped 8.01 during the previous semester. This removed ~30% of the students that copied more than 40% of their homework. Still, the weighted average of S-R copying (detected copying) is 4.1 +/- .7% (9.3 +/- .7%), p value $< 1 \cdot e^{-6}$.

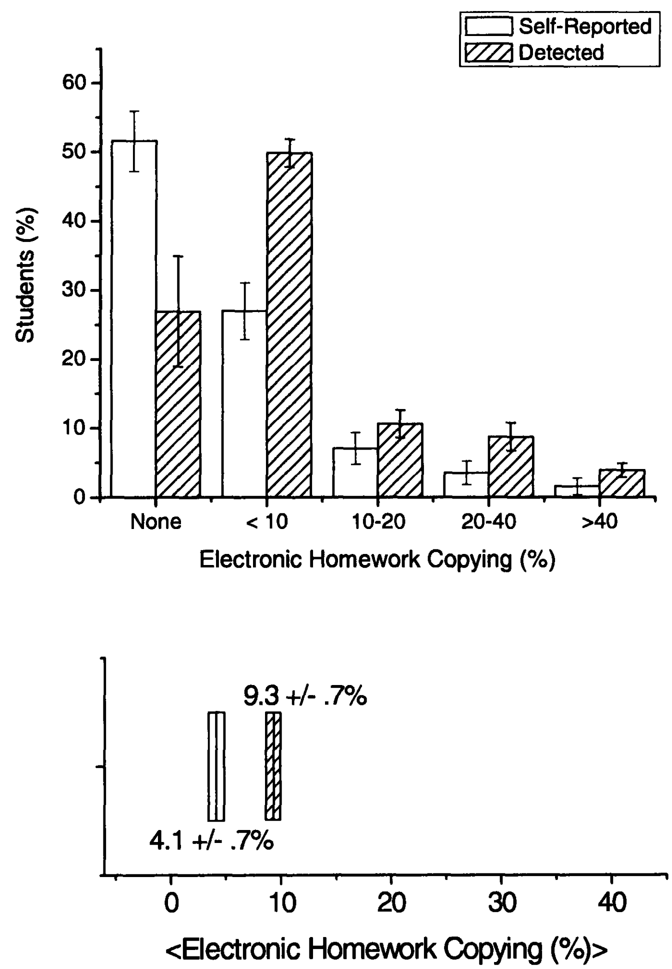


Figure 3-8: Self-Reported Electronic HW Copying vs. Detected HW Copying, 8.01 Fall 2005. 50.4 +/- 4.4% of students surveyed reported copying no electronic homework. Only 26.9 +/- 8% of students were not detected copying electronic homework. 49.8 +/- 2% of students were detected copying < 10% of electronic homework, while only 26.1 +/-4.1% of students reported copying < 10%. The lower plot shows the weighted average of both SR homework copying (4.1 +/- .7%) and detected homework copying (9.3 +/- .7%).

	Self-Reported	Detected
None	50.4 +/- 4.4	26.9 +/- 8
< 10%	26.1 +/- 4.1	49.8 +/- 2
10-20%	7.8 +/- 2.3	10.6 +/- 2
20-40%	3.7 +/- 1.7	8.7 +/- 2
> 40%	1.9 +/- 1.2	3.9 +/- 1

Table 3-4: Percentage of Self-Reported Electronic HW Copying vs. Detected Electronic HW Copying for Fall 2005. ~33% less HW copying was reported than detected. SR copying errors were calculated using a binomial distribution with a 95% confidence level. Detected copying errors calculated by observing the change in each respective copying category when the probability of copying was raised to a much higher threshold (probability > .90 vs. .75).

Our conclusion that we observe ~50% less reported copying than detected copying is dependent on the many students we believe are copying < 10%. We support this claim by discussing both the methodology of error approximation within the copying algorithms and formative evidence behind the students we consider to be "occasional" copiers. Each of the two copying algorithms estimate the probability that a student copied a specific problem, and a student problem is considered copied when either copying probability is > .75. While the calculation of the error for each S-R copying group is straightforward (we used a binomial distribution and a 95% confidence interval), a different procedure was used to calculate the error for each detected copying group. The error is the change in the fraction of students in each copying bin when the cutoff threshold for copying (probability > .75) was increased to .90.

With the exception of the < 10% copiers, each copying bin changed very little with the increased proababilistic threshold. While increasing the certainty that each detected problem was actually copied, an increased threshold does not impact our conclusions that ~50% of the class engaged in "occasional" homework copying. Like other cheating detection algorithms [66], the final decision regarding a measurement of dishonesty is an arbitrary cutoff. Raising the copying threshold to 90% only reduced the fraction of "occasional" copiers (students who copied < 10%), from 50 +/- 3% to 47 +/- 3%. This latter fraction of "occasional" copiers remains significantly higher than the 26% of students that self-reported copying less than 10% of their homework.

Because both algorithms focus on different aspects of a student's interactions with the electronic tutor, we believe that either probability is a true indication of the honesty of a student problem. Our multi-algorithm approach is also supported by other statisticians, notably ACT researchers who focus on the detection of dishonesty within their standardized tests [51]. Despite the limitations discussed, we believe our analysis points to 50% underreporting through the use of the self-reported survey. Our conclusions are in accord with Erickson's [29] conclusions, who also showed that significant differences can exist between self-reported cheating data and detected cheating, and furthers our argument that self-reported survey data is not as accurate as many researchers contend.

3.4 Survey Results and Correlates of Cheating

This section summarizes the relationships observed between four cheating correlates and self-reported cheating. Although many correlates of cheating have been previously investigated, many of these query demographic characteristics (e.g. the background of the surveyed students). Due to our efforts to keep our survey anonymous, we chose to focus on four cheating correlates not specifically related to demographic information like age, sex, or race:

- Prospective Major
- Task Orientation
- Cheating Seriousness
- High School Science HW Copying

Prospective Major. In Chapter 1 we concluded that, although some existing literature supports a dependence on academic major, the overall literature does not support statistical differences in self-reported cheating between specific academic majors. Therefore, we should expect to see no differences in our data as well. Students were asked to report which of five MIT colleges their prospective major would likely come from: Science, Engineering, Management, Humanities, or Other. Prospective major will be compared with two self-reported cheating measures: a combined cheating index based on 10 forms of self-reported cheating, including test cheating, plagiarism, and unauthorized collaboration, and with the fraction of self-reported 8.01 written and electronic homework copying. For analysis of the 10 self-reported cheating questions, the following scoring system was used:

Self-Reported Cheating Frequency	Cheating Score
None	0
Once	1
More Than Once	3

Table 3-5: Scoring Scheme for 10 forms of self-reported cheating.

A total cheating score is calculated for each student by summing their individual scores over each of the 10 forms of cheating. Students are then grouped by major, and an average cheating score calculated within each major (Fig 3-9). We observe no statistical differences between the reported cheating of different majors. Although students who chose "other" as their prospective major reported more cheating than other majors, this group included only 8 students, thus the large error associated with this measurement negates any statistical significance (as does the error on the lower value for the humanities).

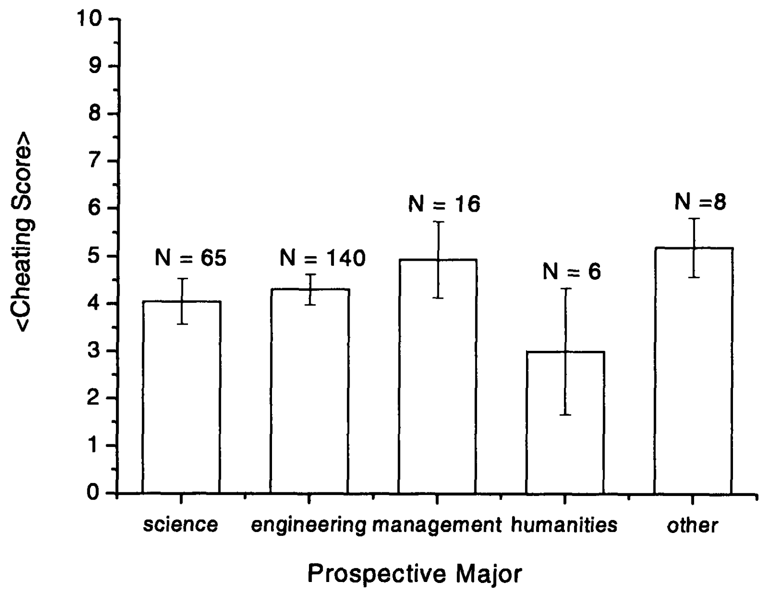


Figure 3-9: Prospective Academic Major vs. 10 forms of self-reported cheating. We observe no statistical differences among five prospective majors and their self-reported cheating behaviors.

For two additional questions asking students to self-report the fraction of 8.01 written and electronic homework copied (none, < 10%, 10-20%, 20-40%, and > 40%) the following scoring system was used:

Self-Reported HW Copying	Written HW Score	Electronic HW Score
None	0	0
< 10%	.05	.05
10-20%	.15	.15
20-40%	.3	.3
> 40%	.5	.5

Table 3-6: Scoring scheme for self-reported 8.01 written and electronic homework copied

For each prospective major, an average self-reported copying score was calculated for 8.01 written, electronic, and total homework (Fig 3-10). The total homework score was calculated by averaging the written and electronic homework scores for each student within a particular major. We also observe no differences across prospective major with respect to 8.01 written, electronic, or total homework.

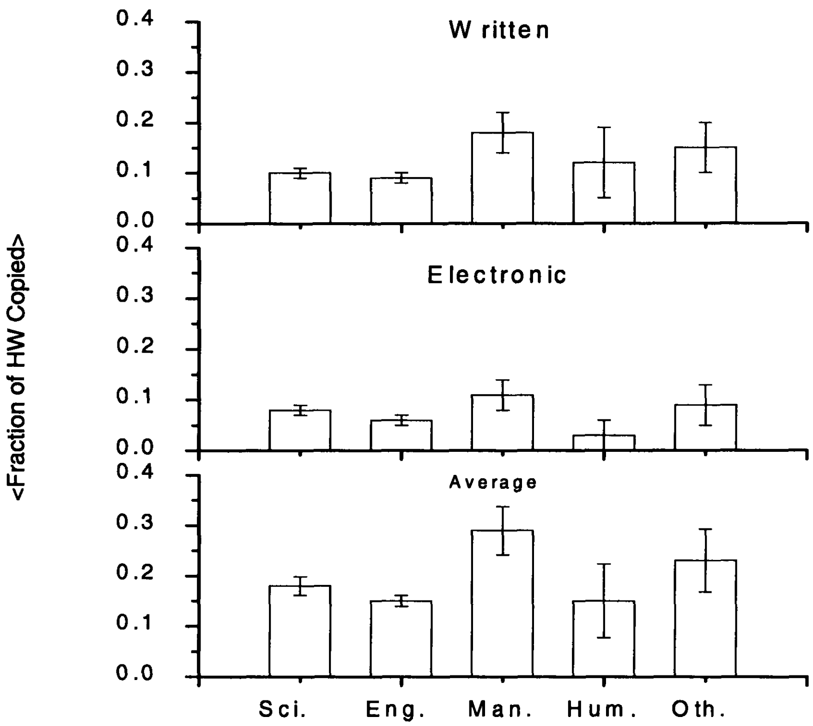


Figure 3-10: Prospective Major vs. Self-Reported 8.01 HW Copying. No significant differences are observed between the self-reported copying of 8.01 written, electronic, or average homework.

Task Orientation. In Chapter 1, we concluded that available evidence supported a negative correlation between wanting to learn as opposed to wanting to receive a good grade (called task orientation) and self-reported cheating. However, further research seemed required to be sure. Two questions were presented to students in order to measure task orientation. The first question asks:

"An organization has recruited you for your dream career. They can allow you to remain at MIT for only two years, but will provide you with your choice of tutors:"

- "Degree Tutor": Will help you earn enough academic credit to get your degree, but you will learn little
- "Teacher Tutor": Will help you learn 4 years material, but you will receive little academic credit.

This first scenario assesses a student's general attitudes toward his collegiate education, in effect measuring an "overall" level of task orientation. The second question asks:

"On balance, which of these are your motivations for 8.01/8.02?"

- "Mastery Learning": Motivated to master the concepts of Mechanics/Electromagnetism
- "Grade Oriented": Must complete this class because it is a degree requirement

This question assesses a student's task orientation within the course.

Overall, 61% of students chose the "Teacher Tutor," evidence that on the whole MITF believe they are in college to learn and master a discipline. On the other hand, only 31% of students chose "mastery learning" for their relevant course objectives in this introductory course. This is deeply disturbing as 77% of all students chose science or engineering as their future prospective major. If all those desiring a "teacher tutor" chose "mastery learning" then 70% would have given the same answer to both questions; if they chose "grade oriented" randomly, the communality would be just 46%. Thus the fact that just 54% of students answered both task orientation questions in a similar direction is evidence of a fairly high degree of disinterest in 8.01/8.02, perhaps not surprising for a course required of all students that most of the prospective physics majors do not take..

Of the 63 students that chose science as their prospective major, 25 +/- 6% (n = 16) indicated that their course goals were "mastery learning." Of the 139 students that chose engineering as their future prospective major, only 45 +/- 6% (n = 63) indicated that their course goals were "mastery learning." This probably reflects the fact that the most popular science is Biology, and most of those students don't see the relevance of physics to their intended major.

A student's self-reported task orientation is compared with their self-reported cheating behavior using the same 10 forms of cheating and scoring system as above. A total cheating score is calculated for each student by summing their individual scores over each of the 10 forms of cheating. Students were then grouped by their reported task orientation for each of the two task orientation scenarios and an average cheating score was calculated for each student response group. Figure 3-11 summarizes these comparisons. Students who chose "teacher tutor" vs. "degree tutor" averaged significantly lower cheating scores, 3.86 +/- .29 vs. 5.19 +/- .43 (p-value < .001). However, the correlation was stronger with task orientation toward the physics course: students who chose "mastery learning" averaged ~35% lower cheating scores than students who chose "grade oriented," 3.26 +/- .38 to 4.95 +/- .32 (p-value < .001). A "total" task orientation score is calculated by combining responses for each of the two scenarios, with a student responding either "teacher tutor" and "mastery learning" (e.g. total positive orientation), "degree tutor" and "goal oriented" (e.g. a total negative orientation), or the student responded to the questions in a mixed fashion. No differences were observed between the two mixed states, therefore they are combined for presentation as one state. A clear relationship is observed between a student's total task orientation and the average cheating scores of those students. Students who chose both "teacher tutor" and "mastery learning" averaged the lowest cheating scores, 3.04 +/- .45. Students who were responded to both task orientation questions in a mixed fashion averaged 4.37+/- .35 and students who chose both "degree tutor" and "grade oriented" averaged the highest cheating scores, 5.63 +/- .51 (p-value for comparison between positive orientation and negative orientation < .0001).

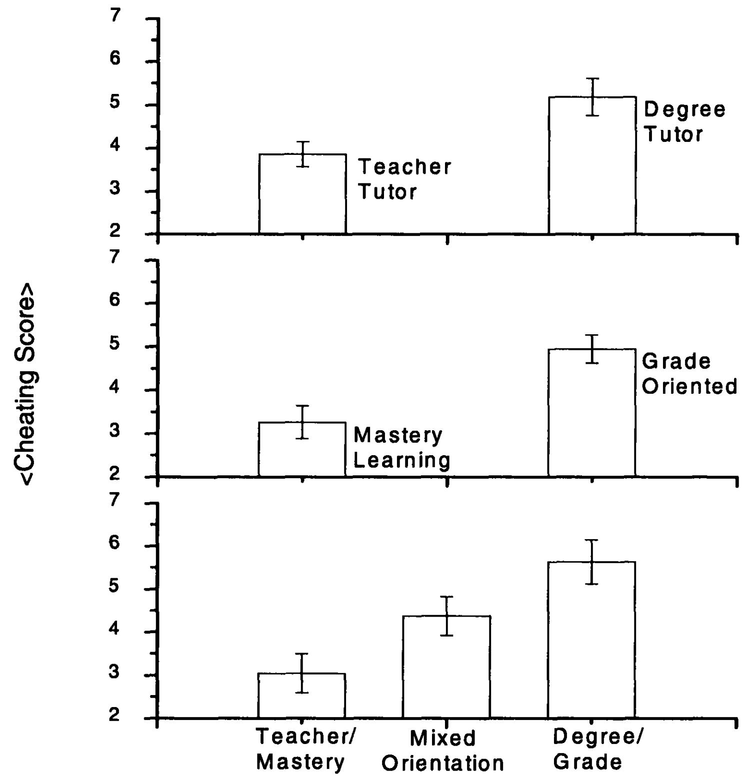


Figure 3-11: Task Orientation vs. 10 forms of self-reported cheating. (A) Students who chose "teacher tutor" reported ~25% less cheating than students who chose "degree tutor." (B) Students who chose "mastery learning" reported ~30% less cheating than students who chose "grade orientation." (C) We observe steadily increasing cheating scores with decreasing total task orientation.

Next, task orientation is compared against total homework copying - the fraction of self-reported 8.01 written and electronic homework copied. Again, the same scoring system used above is applied for this analysis. The total homework copied by each student is calculated by averaging the self-reported fraction of written and electronic homework copied . We observe similar trends as reported above for overall cheating – an orientation toward learning rather than grades is negatively related to the fraction of 8.01 homework copied. Figure 3-12 shows that for both task orientation questions, the fraction of written and electronic homework copied decreases by an average of 40% for students who were positively oriented. Figure 3-13 shows the combination of the two task orientation measurements using the same method as above, with similar results. Students who chose both positive measures of task orientation copied 45+-5%

less homework than students who chose both negative measures of task orientation and copied ~30% less homework than students who responded with a mixed task orientation.

Only one other author, that we know of, has also empirically investigated the relationship between cheating and reasons for studying. Newstead et al. [103] reported that students who chose "personal development" reported they had engaged in an average of 17% of 21 cheating related behaviors (error not reported). Students who chose "means to an end" reported they had engaged in an average of 23% of the same cheating behaviors. Although their results are not as significant as the results we report here, they also conclude that students report less cheating when positively oriented toward learning. Other authors have suggested this relationship [115], though no empirical results were reported. Our results support the conjectured negative correlation between a true desire to learn, and both cheating overall and more specifically homework copying. Moreover, our results strengthen the only other empirical evidence published.

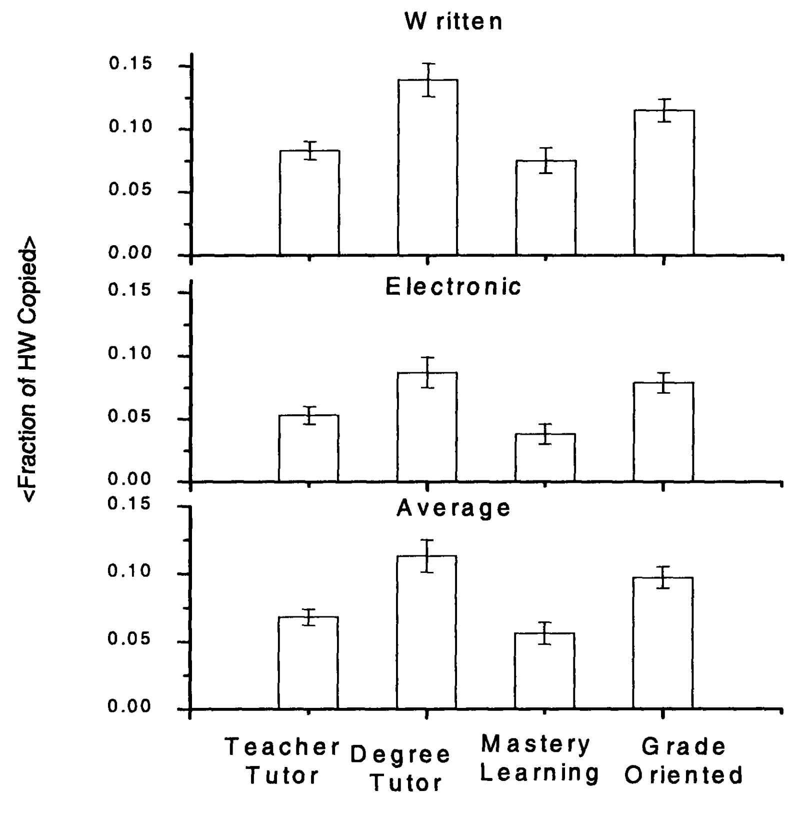


Figure 3-12: Task Orientation vs. 8.01 Self-Reported HW Copying. (A) Task Orientation vs. 8.01 Written HW Copying. Students who chose positive measures of task orientation averaged ~40% less written homework copying, p-value between Teacher Tutor (TT) and Degree Tutor (DT) < .0001, p-value between Mastery Learning (ML) and Grade Oriented (GO) < .001. (B) Task Orientation vs. 8.01 Electronic HW Copying. Students who chose positive measures of task orientation averaged ~35% less electronic homework copying p-value between TT and DT < .001, p-value between ML and GO < .0001. (C) Task Orientation vs. Total HW Copying. Students who

chose positive measures of task orientation averaged ~40% less average homework copying, p-value between TT and DT < .0001, p-value between ML and GO < .0001.

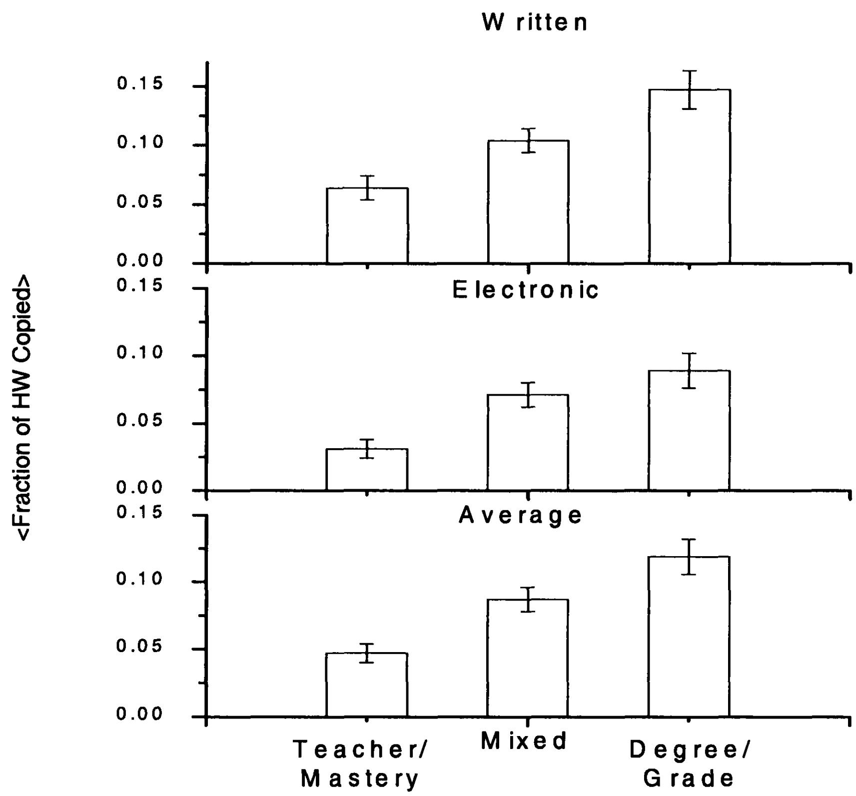


Figure 3-13: Total Task Orientation vs. 8.01 Self-Reported HW Copying. (A) Total Task Orientation vs. 8.01 Written HW Copying. Students who chose both positive measures of task orientation averaged ~50% less written homework copying than students who chose both negative measures of task orientation, p-value < .0001. (B) Total Task Orientation vs. 8.01 Electronic HW Copying. Students who chose both positive measures of task orientation averaged ~65% less electronic homework copying than those who chose both negative measures of task orientation, p-value < .0001. (C) Total Task Orientation vs. Total HW Copying. Students who chose both positive measures of task orientation averaged ~60% less homework copying than those who chose both negative measures of task orientation, p-value < .0001.

Seriousness. For each of the 10 survey questions asking students to self-report their behavior frequency, there was a companion question asking students to gauge how serious they believed that behavior to be (Not cheating, Trivial Cheating, Moderate Cheating, or Serious Cheating). For each category, the following scoring system was used to measure each student's "tolerance" of each form of cheating:

Self-Reported "Tolerance"	Score
Not Cheating	3
Trivial	2
Moderate	1
Serious	0

Table 3-7: Scoring scheme for seriousness of cheating questions

For each student, a total "tolerance" score was calculated using the average of each individual score. Self-reported tolerance and self-reported cheating are then compared using the same scoring system as with both prospective major and task orientation. Average cheating score is calculated for each student over each of the 10 forms of cheating and then correlated with their average tolerance scores (Fig 3-14). A significant positive correlation is observed between a student's average cheating tolerance and their average level of dishonesty, $r = .45$, $p < .0001$.

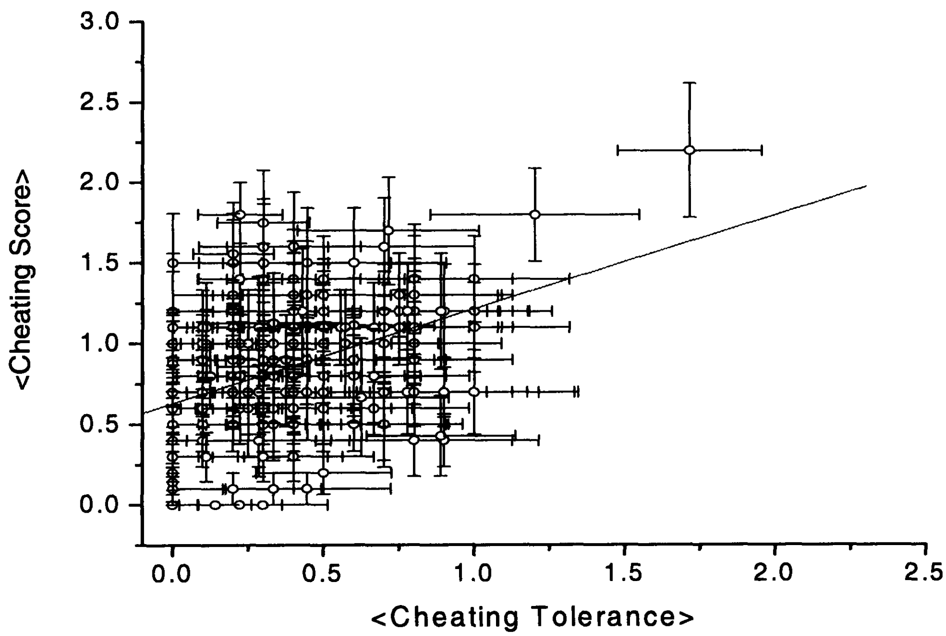


Figure 3-14: Cheating Frequency (CF) vs. Cheating Tolerance (CT). A significant, positive correlation is observed, $r = .45$, $p < .0001$, $N = 248$. The slope of the regression line is $\beta = .56 \pm .02$ CF/CT.

Cheating tolerance is also compared to the fraction of self-reported 8.01 written, electronic, and total homework copied using the same scoring method as above and average "tolerance" scores were calculated for each student. A significant positive correlation is observed between the average "tolerance" score and the self-reported fraction of written homework problems copied, the self-reported fraction of electronic HW problems copied, and the total HW copied (Fig. 3-15). Thus, students who have less tolerance for dishonesty report that they copy less homework than students who have more tolerance. (Or perhaps those who feel obliged to report more copying justify their actions a posteriori by saying that it is not so bad.) Fitting a least squares regression line to each plot allows us to extrapolate how tolerance is related to the number of problems copied. Over the term, ~85 problems were assigned to the class, ~35 written problems and ~50 electronic problems, thus the slope of the regression line can be interpreted as tolerance/HW problem copied. For the total HW copied, the slope of the regression line observed is .36 +/- .04 tolerance/problem copied. We observe the intercept (students who self-reported no homework copying) of the regression line at tolerance = .69 +/- .04, between moderate and serious. For students who copied more than 40% of homework, their extrapolated tolerance is 1.31 +/- .04, between moderate and trivial, ~50% higher than students who reported no copying.

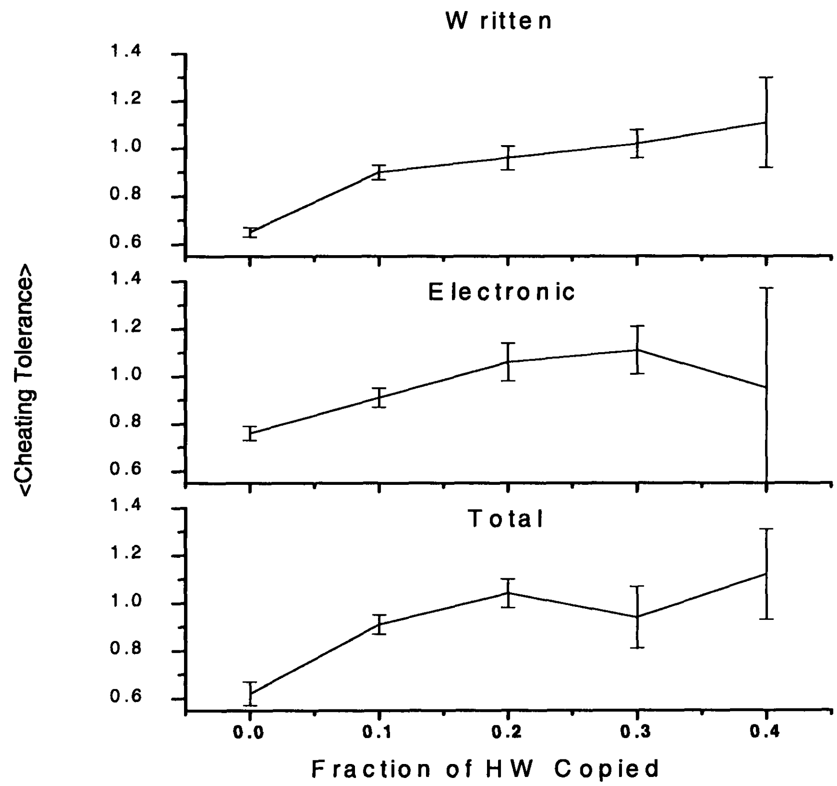


Figure 3-15: Cheating Tolerance vs. Self-Reported 8.01 HW Copying. (A) Tolerance vs. reported Written HW Copying (error bars are std deviation of mean of students reporting that particular fraction of HW copying). A significant positive correlation is observed between the average "tolerance" score and the self-reported fraction of written homework problems copied, r = .93, p < .02. The regression line has slope β = .41 +/- ..03 /written HW problem copied. (B) Tolerance vs. Electronic HW Copying. A significant positive correlation is observed between the average "tolerance" score and the self-reported fraction of electronic homework problems copied, r = .98, p < .005. The regression line has slope β = .25 +/- .05 /electronic HW problem copied. (C) Tolerance vs. Total HW Copying. A significant positive correlation is observed between the

average "tolerance" score and the self-reported fraction of written homework problems copied, $r = .87$, $p < .05$. The regression line has slope $\beta = .36$ +/- ..04 /HW problem copied.

Self-Reported High School Science HW Copying vs. Self-Reported 8.01 HW Copying. In Chapter 1, we presented conclusive evidence that students self-report 2x more cheating during high school than during college. Our survey question asked students to report the fraction of high school science homework problems they copied, using the same scale as our questions for written and electronic homework (none, <10%, 10-20%, 20-40%, and > 40%). These data are then compared to the average fraction of students who self-reported copying 8.01 written homework to check whether this finding would apply to MIT students (Fig 3-16). We compared only written homework because we believe it is unlikely the students were exposed to on-line science homework in high school. Based on our results from Chapter 1, we expected to observe higher levels of self-reported homework copying within high school science courses than for 8.01 written homework. However, we observe the opposite effect. Students self-reported significantly lower levels of high school science homework copying than 8.01 written homework copying. One possibility is that high school cheating summarized in Chapter 1, which was undetermined as to the specific form of cheating, may only apply to test cheating and not homework copying. Another possibility is that MIT students, among the top high school students nationally, may not have been challenged there, but have been more severely challenged at MIT. On the other hand, the copying may reflect that they are on pass-no record, so that most students feel shortchanging their studies will have no effect on their grade.

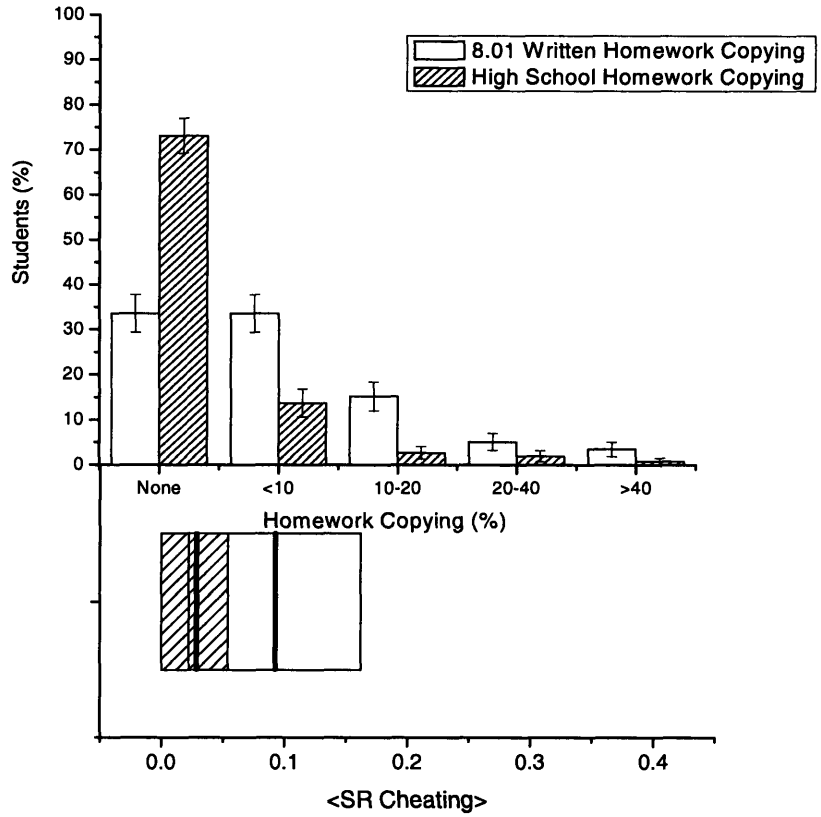


Figure 3-16: Self-Reported High School HW Copying vs. Self-Reported 8.01 Written HW Copying. Errors for the top graph were calculated using a binomial distribution with a 95% confidence level. The bold line on the lower graph indicates the 8.01 and High School Copying mean; width of each box is the respective standard deviation of the mean.

Summary of cheating correlates.

We have investigated the relationships between four correlates of cheating and the self-reported cheating behaviors of MITF: academic major, task orientation, cheating tolerance (or seriousness), and high school homework copying. Of these four correlates, we failed to observe significant differences for only one correlate - academic major. However, in Chapter 1 we summarized existing evidence, which pointed to no significant differences between the cheating of different academic majors. Therefore, we further support that a student's academic major does not in itself portend a greater propensity to cheat.

With respect to task orientation, existing evidence is mostly circumstantial and the intuitive thoughts of a few authors. Here, we presented strong evidence that task orientation, both for the individual course and at the collegiate level, is strongly correlated with (and presumably predictive of) a student's cheating behavior. We observe that students with a pro-learning task orientation reported at least 40% less cheating than students who reported a good grades task orientation. Further, students with mixed orientation reported more cheating than students with positive orientation and less cheating than students with negative orientation.

A student's tolerance of cheating is directly related to their frequency of reported cheating. We observe a significant positive correlation between a student's cheating tolerance and a student's frequency of reported cheating. At the extreme, students who reported no 8.01 homework copying also reported ~50% less tolerance of cheating than students who reported they had copied at least 40% of all homework.

First Year Student Survey Conclusions

In this chapter we have examined the self-reported cheating behaviors of a population of MIT Freshmen, comparing their reported cheating behaviors and beliefs to students nationwide, MIT Freshmen from 1992, and against levels of detected 8.01 electronic homework copying from the previous term. Finally, we investigated conclusions from our cheating literature survey (Chapter 1) as related to four correlates of cheating: prospective major, task orientation, cheating tolerance, and high school science homework copying. Our results include both disquieting, and at the same time, encouraging news for the MIT community.

Overall, MITF report ~30% less dishonesty and tolerance of 8 various forms of cheating than their national counterparts. MITF also believe that ~20% less plagiarism and test cheating occurs throughout the MIT campus than their national counterparts. Do these two measures truly indicate a more ethical environment at MIT, or are they artifacts of survey underreporting? Despite survey inaccuracies, we believe that the consistency of the results does indicate a more ethical environment at MIT. We also show evidence that MITF may be slightly less tolerant and engage in slightly less cheating than MITF from 1992. These longitudinal comparisons, though primitive, are important to understanding the dynamics of the institutional ethical culture. These observations further our analysis from Chapter 1 that overall little evidence exists to support widespread increases of student cheating over the past few decades.

The fraction of students surveyed that reported cheating at least once over the past year is 81%; this fraction, though large, is comparable to other undergraduate survey results [19]. Most of this is in the form of unauthorized collaboration; further, only 24% report some form of plagiarism and only 3% report any form of test cheating. We also predict that the fraction of students cheating may decrease despite many more opportunities to cheat as their academic careers advance. This encouraging outlook is due to the fact that most MITF reported a positive collegiate task orientation, i.e. they believe their efforts at MIT are fundamentally to learn, and not just to obtain a degree. As these freshman enter specific courses of study during their sophomore year, task orientation should become positive within courses tailored to their academic major, and we would expect cheating to be significantly reduced given the high correlation observed between improved task orientation and reduced cheating.

Our survey is unique because it validates self-reported survey data, unlike all but 1 of the ~100 papers reviewed in Chapter 1. We found that ~33% less 8.01 electronic homework copying was reported than detected. Thus, we have found a significant real-life discrepancy between survey self-reporting and actuality, as Erickson [29] did in a laboratory setting. This evidence makes it clear that the actual detection of cheating, whether through computer software or another manual human effort, is paramount to accurately determining the scale, depth, and correlates of student cheating.

4 Conclusions

Starting with the historical perspective gained by summarizing past cheating research, this thesis has sought to understand the nature of physics homework copying: How often are students copying, who copies, why do they copy, where do they copy, when do they copy, and what are the effects of homework copying on student learning.

The data contained herein could have been solely gathered using self-reported surveys. We could have asked students when they copied homework, from which assignments they copied more homework, etc. However, in order to more fully, and more accurately, understand homework copying, we directly measured student copying (a comparison with reported copying shows that there is as much as a ~30% discrepancy between what was actually copied and what was reportedly copied). From three successive Newtonian Mechanics courses we report that ~10% of all student-problems were detected as copied. Although only 5% of students copied more than half of their homework, suprising is the large fraction (57%) of students who "occasionally" copy their homework (<10% of the time). Overall, more than 86% of all students were guilty of at least "occasional" homework copying.

One idea stands apart: Success within a challenging course, such as MITs freshman physics, follows from hard work. As a group, non-copiers have 4x lower attrition rates and their final exam scores averaged 1.2 standard deviations higher than students who regularly copied their homework. Non-copiers also do more practice problems prior to exams than copiers and work their homework problems at a steady rate, completing half of their interactions up to 24 hours before copiers.

Homework copying, (a form of unauthorized collaboration) is often rated the least serious form of cheating by both faculty and students. However, our results show that homework copying is more deleterious than other forms of cheating, in both scale and consequences. First, the scale of the more serious forms of cheating, particularly test cheating and plagiarism, is typically reported by only ~5% of students; further, although a failed test cheating attempt could earn you harsh penalties, only 5% of these cheating students are ever caught. However, we detect that the fraction of students who copy homework is much larger (see above). Second, we observe distinct consequences for student learning and course performance within the group of students who copy more than 30% of their electronic homework. These students who engage in a "harmless" act of homework copying consistently perform below their non-copying peers.

The news is not all bad: We also report that homework copying significantly declined between the Fall 2003 class and the Fall 2005 class; 14% of all assigned problems in Fall 2003 were copied compared with 8% of all assigned problems in Fall 2005. Although a separate chapter detailing copying remediation could not be completed in time for this thesis, much thought and effort has been expended substantiating this decline. With the 2005 class a host of remediation measures were instituted: some internal to the TEAL course format, and some driven by our research into copying behavior and the earlier reported copying patterns (Chapter 2). Unfortunately, we do not know the exact reason for this observed decline in copying. The decline may solely be an attribute of the TEAL format (vs. the traditional large lecture format of the Fall 2003 class), or it may be an artifact of shorter assignments, or both. Other remediation measures also included a presentation of the harmful effects associated with copying homework and the identification of students "at-risk" of course failure only 1/3 of way through the course (based on their exam 1 performance and the fraction of homework copied). Although we can't pinpoint the exact reason for this decline, we do not believe it to be either an error within our copying detection process or a random occurrence. We plan further research and inquiry in order to better understand the effects of our remediation measures and further reduce homework copying.

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Appendix A

Self-Reported Cheating Survey Data

This appendix lists the 88 self-reported cheating surveys compiled for our analysis of the prevalence of collegiate cheating and it's dynamics between 1955 and 2005. The reported numbers in each cell refer to the percentage of students that reported engaging in the specific form of cheating. The following key details each of the 11 forms of cheating analyzed:

Key	Form of Cheating
1	General Cheating
2	Exam Cheating-General
3	exam-copied from another student
4	exam-helped another student cheat
5	exam-used crib notes
6	copied material w/o footnoting
7	plagiarized
8	falsified a bibliography
9	turned in work by another
10	unauthorized collaboration
11	Homework Cheating

Author, Pub Date	N	Location	Year	Subject	1	2	3	4	5	6	7	8	9	10	11
Ackerman, 1971	227	Wichita State University	1	Psyc	48	31									
Altemeyer, 1988	200	unk	all	unk		23									
Altemeyer, 1988	90	unk	all	unk											27
Baird, 1980	200	Bloomburg State Coll	all	all	76	28									
Bloomfield, 2000	400	U Virgina	1	all							15				
Bowers, 1964	5000	90 different schools	unk	unk	75		26	23	16	49	30	29	19	11	
Brown, 1995	207	unk	grad	busi	81		3	40	7		19	23	5	32	
bunn, 1992	476	Auburn	all	all		50									
Cozin, 1999	298	Rantan Valley CC	all	all		29		39	27	50	29	31	16	38	
davis, 1992	~6000	nationwide	all	all	76										
Davis, 1994	2153	unk	unk	unk	49										
Dawkins, 2004	858	unk	all	all	41	41					19				
Deinstbier, 1980	516	U Nebraska Lincoln	1	Psyc		26									
diekhoff, 1996	474	unk	all	all	61	23	26	17	14		8		4		45
diekhoff, 2002	451	unk	all	all	68										
eskridge & Ames, 1993	639	Nebraska	all	all	95		50								
Eve, 1981	650	unk	unk	unk	63		44	42	17	29		20	12		
Faulkender, 1994	600	U Southern Missisippi	all	Psyc		56									
Ferrari, 2005	63	DePaul University	all	all		12					28				
Genereaux, 1995	365	Mount Royale College	all	all			20	28	19		27	29	10		
Goldsen, 1960	519	Wayne	unk	unk	49										
Goldsen, 1960	516	Texas	unk	unk	43										
Goldsen, 1960	467	UCLA	unk	unk	39										
Goldsen, 1960	1151	Cornell-men	unk	unk	38										
Goldsen, 1960	488	Mchigan	unk	unk	36										
Goldsen, 1960	365	Dartmouth	unk	unk	26										
Goldsen, 1960	297	Yale	unk	unk	24										
Goldsen, 1960	414	North Carolina	unk	unk	23										
Goldsen, 1960	277	Wesleyan	unk	unk	13										
Goldsen, 1960	453	Harvard	unk	unk	11										
Goldsen, 1960	4900	Total	unk	unk	33				37						
Graham, 1994	408	Mt Mercy College	unk	unk			26	24	26		14		8		63
Greene, 1992	82	unk	unk	unk	81										
Haines, 1986	380	small state univ	1/2	unk	54	24									34
Hale, 1987	109	Large State University	unk	unk							55				
Hale, 1987	197	Large State University	unk	unk							55				
Harp & Taietz, 1966	1929	Ivy League School	all	all							50				
Hawley, 1984	425	Idaho-Moscow	all	all									15		
hollinger, 1996	1672	unk	all	all	68	47	26	22	10	33			8		27
Houston, 1986	100	unk	unk	Psyc		22									
Huss, 1993	220	Emporia State	unk	unk	44										
Jendrek, 1992	776	Miami	all	all	74		25	25							
Johnson et al. 2004	590	UCSB	1	all							1				
johnson, 1971	27	U Wisconsin Mil	all	all	33										
kerkvliet, 1999	398	Oregon State Univ	all	all		13									

Author, Pub Date	N	Location	Year	Subject	1	2	3	4	5	6	7	8	9	10	11
Knowlton, 1967	533	Large State University	all	all	65										
Knowlton, 1967	186	small state univ	all	all	81										
Lambert, 2003	850	unk	all	all	83										
Lanza-Kaduce, 1986	175	large southeastern	1/2	Psyc		30									
Leming, 1980	78	Large State University	1	Psyc	36										
Lipson, 1993	891	MIT	all	all		12	5	5	7	42	20		2	67	60
Liska, 1978	359	SUNY Albany	all	all				72	22		35		19	25	
May, 1993	177	U Virginia	4	Psyc	24	9									18
McCabe, 1992	6096	31 colleges	4	all	67										
McCabe, Trevino, 1994	2240	26 schools	4	all			52	37	27	54	26	28	14	49	
McCabe, Trevino, 1997	1793	9 public colleges	2,3,4	all	82	64									66
McCabe, Trevino, 1999	4285	31 colleges	2,3,4	all	62	37									48
Micheal & Miethe, 1989	623	Va Tech	all	all	86	42					23				76
moffatt, 1990	232	Rutgers	all	all	78										
Murphy, 2002	~300	LSU	all	all	68										
National Survey, 2004	19871	unk	all	all			14	15	11	40	9	21	7	45	
Nelson, 1986	24	small private	1/2	Psyc		50									
Nelson, 1986	45	small private	1/2	Psyc		12									
newstead, 1996	943	unk	all	all			13		8	54	42	44	16	18	46
Nonis & Swift 1998	301	2 univ	all	busi	63	57	57	56	33						
OU Survey, 2004	792	Oklahoma	2,3,4	all			12	10	8	37	6	16	6	43	
Palazzo, 2005	101	MIT	1	all		37	4	33					8	78	60
partello, 1993	34	Keene State College	1	all		6		12			3	3			21
Paynter, 2005	106	U of Auckland	all	all						16	20			46	33
pitts, 2004	3660	univ of victoria	all	all		20				49	50				50
PULSE-1996	354	umass amherst	all	all	72	19	8	19	9	35		23	3		
Pulvers, Diekhoff, 1999	277	3 schools	all	all	12										
roberts, 1998	809	unk	all	all	92		24	29	21		36	42	11	56	50
Scanlon, 2002	298	unk	all	all							30		10		
Shaughnessy, 1988	361	unk	all	all		32	26	34	23	31			10		29
Sierles, 1980	44	Medical School	4	med	88										
sims, 1993	57	unk	grad	busi	91										
singhal, 1982	364	univ	all	Eng	56		7	27	24					10	62
sisson, 1984	287	U Nebraska Lincoln	4	Eng					18					20	
Smith et al. 1975	402	unknown	all	unk	56										
Smith, et al. 1972	112	CUNY	all	all		95									
Stern &Havlicek, 1980	314	unk	all	all	82										
Stokes, 1995	112	unk	2	Psyc			14	8	8	53	57	48	15	51	40
tang, 1997	282	unknown	all	all		39									
tibbets, 1998	330	East Tennessee State	all	all		39									
tom & Borin, 1988	149	large western college	all	busi	49	26									26
Voekl and Finn, 2004	315	unk	all	all	88										
Vowell, 2004	674	unk	all	all	85		35	41							80
Weiss, Davis, 1993	168	Belmont U	all	all	16										

Appendix B

Experimentally Recorded Cheating Data

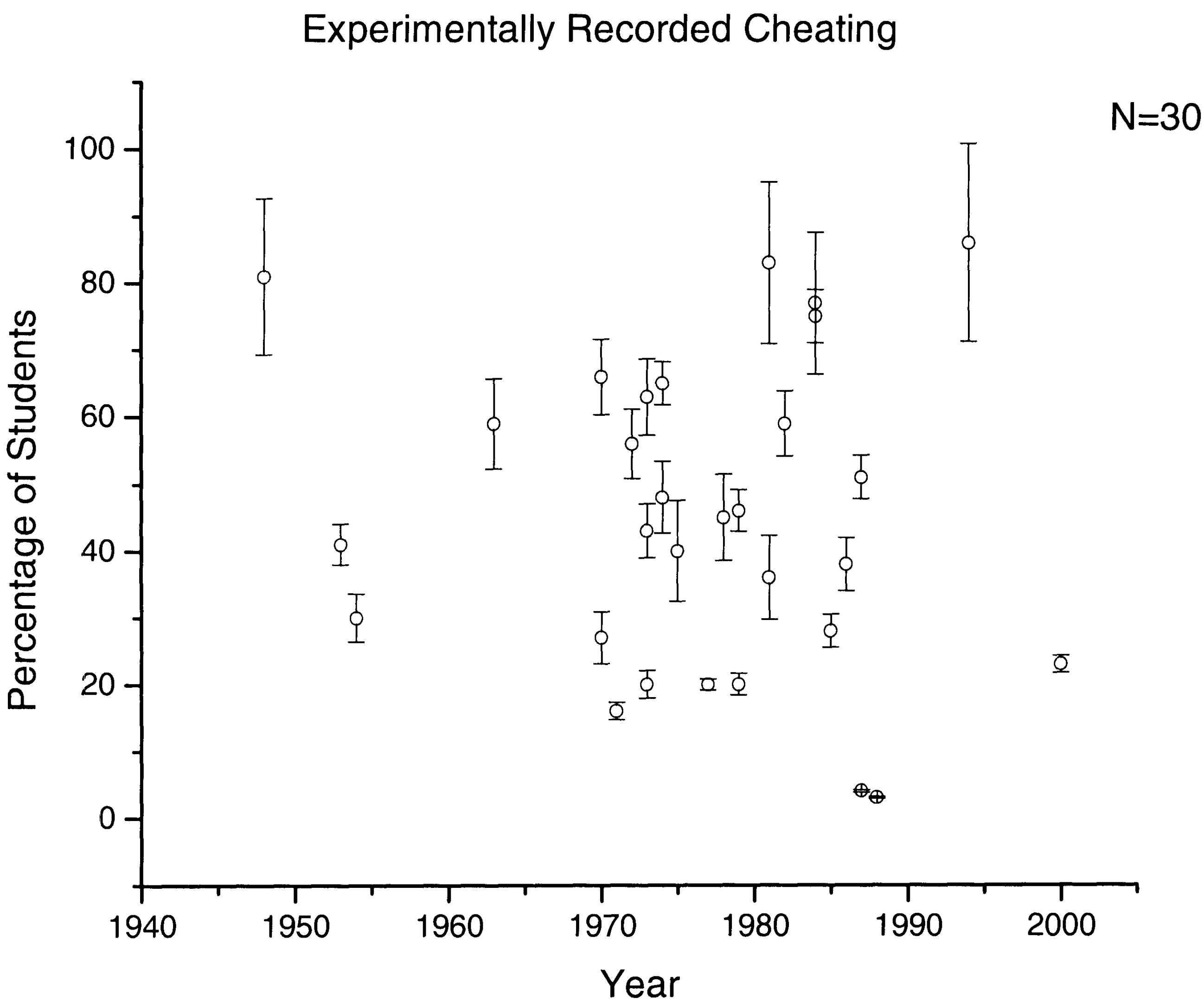
This appendix details the published experimentally recorded cheating data.

Author	Pub Year	Data Year	N	Cheating %
Canning	1956	1948	48	81
Canning	1956	1953	181	41
Canning	1956	1954	70	30
Hetherington	1964	1963	78	59
Deinstbier	1971	1970	49	27
Sherrill	1971	1970	138	66
Fakouri	1972	1971	154	16
Bronzaft	1973	1972	117	56
Millham	1974	1973	91	20
Heisler	1974	1973	123	63
Erickson	1974	1973	113	43
Skrull, Karabenick	1975	1974	80	48
Smith	1975	1974	409	65
Diener	1976	1975	28	40
Kelly	1978	1977	591	20
Vollacher	1979	1978	48	45
Leming	1980	1979	152	20
Kahle	1980	1979	218	46
Forsyth & Berger	1982	1981	33	36
Forsyth & Berger	1982	1981	47	83
Antion and Micheal	1983	1982	149	59
Eisenberger and Shank	1985	1984	357	75
Malinski and Smith	1985	1984	53	77
Ward	1986	1985	128	28
Flynn	1987	1986	91	38
Karlins	1988	1987	708	4
Karlins	1988	1988	666	3
Gardner, et al.	1988	1987	245	51
DePalma, Madey, Bornshein	1995	1994	34	86
Sandoe and Milliron	2000	2000	300	23

Appendix C

Plot of Experimentally Recorded Cheating Data vs. Time

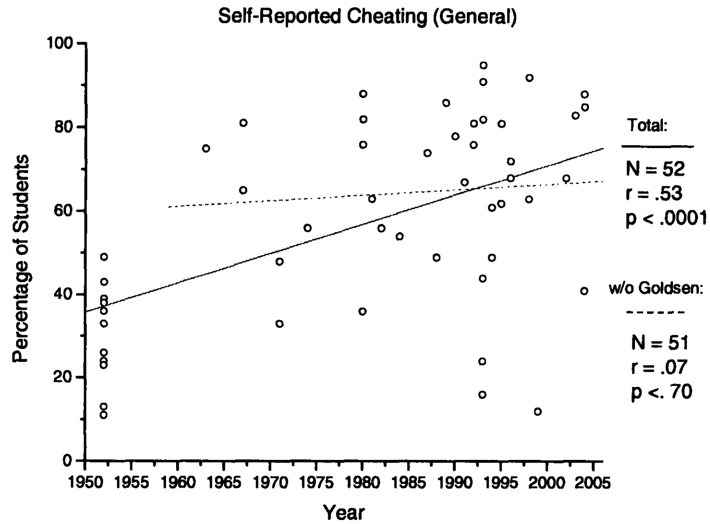
This appendix contains a plot of the fraction of students detected cheating through experimental masurements vs. the year the data was taken

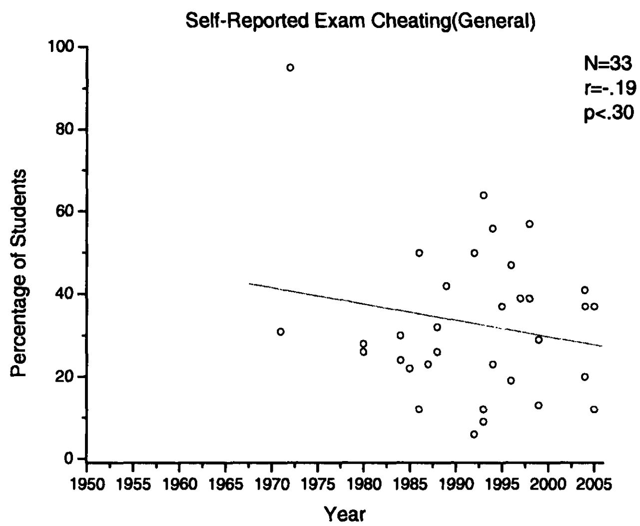

Experimentally Recorded Cheating
N=30
Percentage of Students
Year
0
20
40
60
80
100
1940
1950
1960
1970
1980
1990
2000

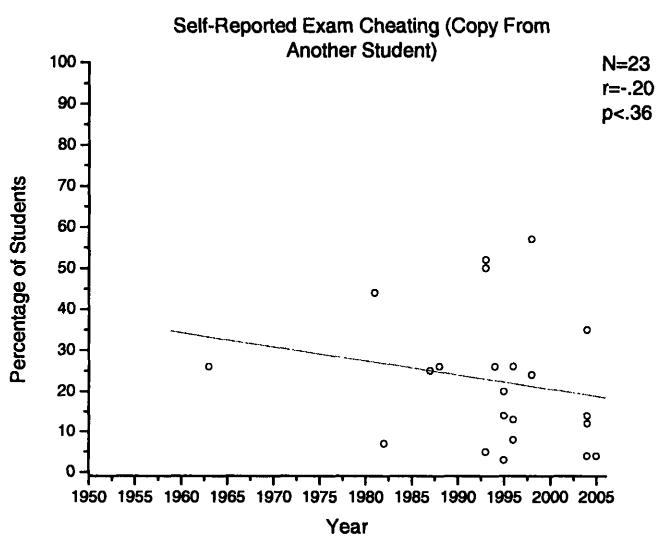
Appendix D

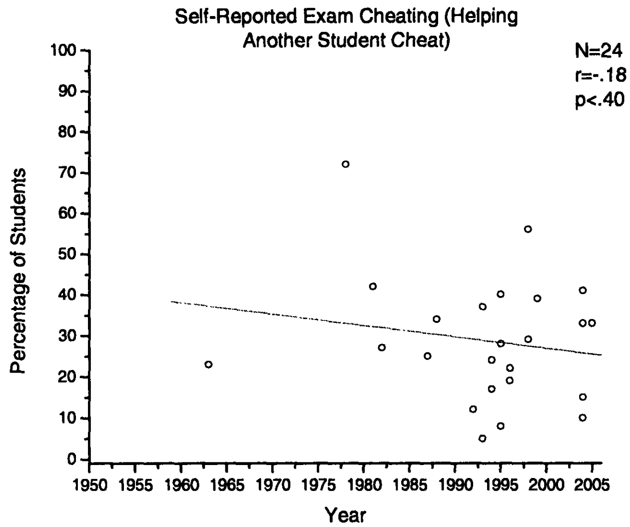
Prevalence of 11 forms of self-reported cheating

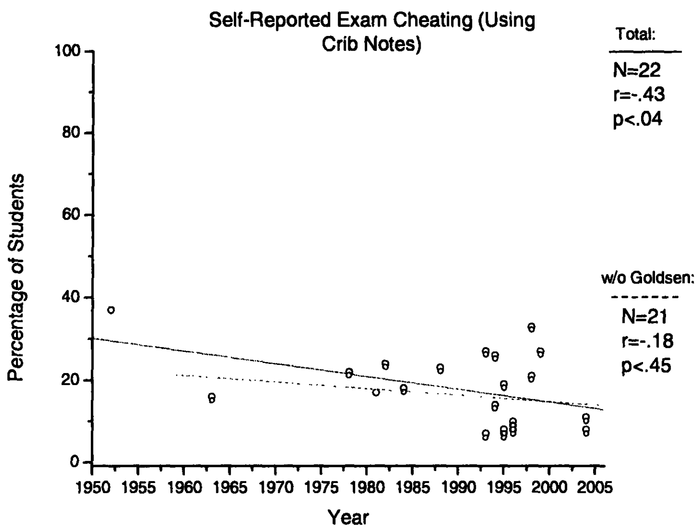
This appendix contains the plot for the prevalence of each form of cheating vs. time. For each form of cheating the following data is listed: the number of studies contained (n), the correlational coefficient (r), and the confidence level of the correlation (p-value).

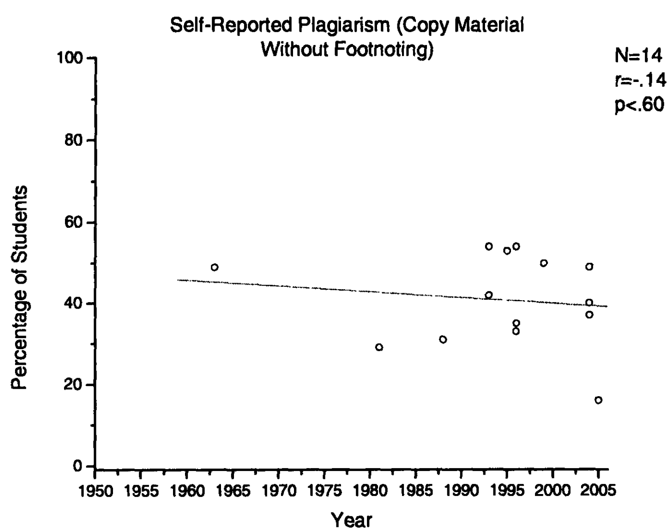

Self-Reported Cheating (General)
Percentage of Students
Year
Total:
N = 52
r = .53
p < .0001
w/o Goldsen:
N = 51
r = .07
p <. 70

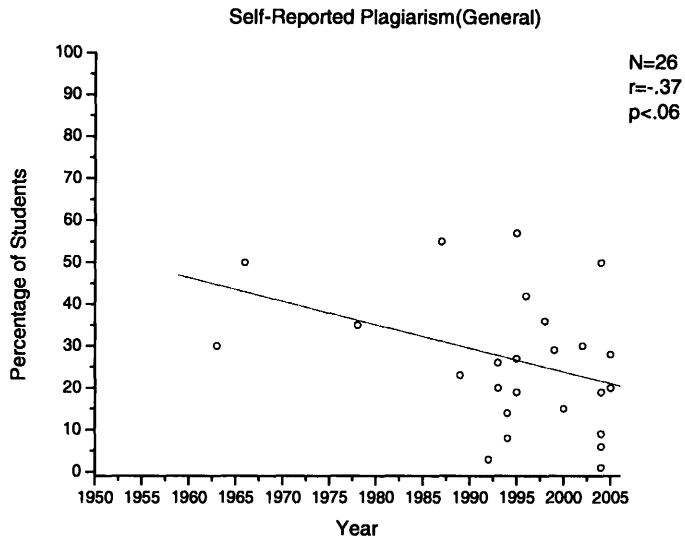

Self-Reported Exam Cheating(General)
N=33
r=-.19
p<.30
Percentage of Students
Year

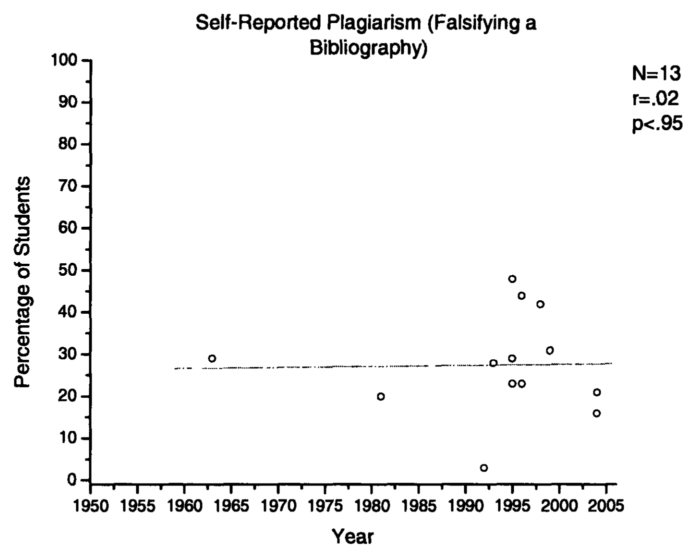

Self-Reported Exam Cheating (Copy From Another Student)
N=23
r=-.20
p<.36
Percentage of Students
Year

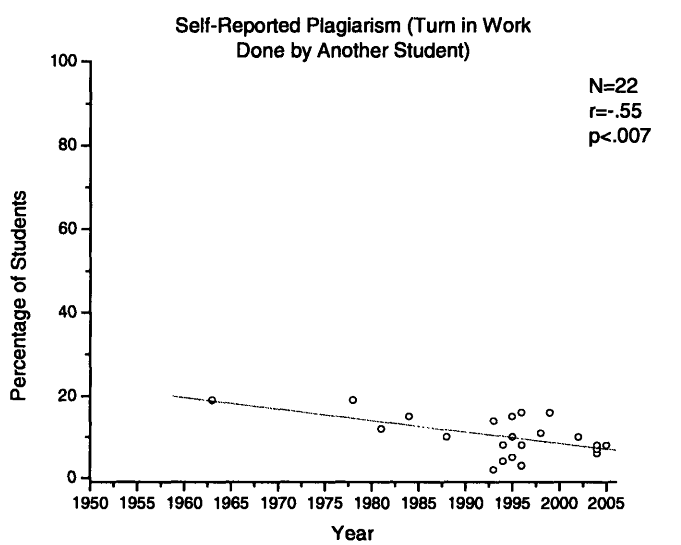

Self-Reported Exam Cheating (Helping Another Student Cheat)
N=24
r=-.18
p<.40
Percentage of Students
Year

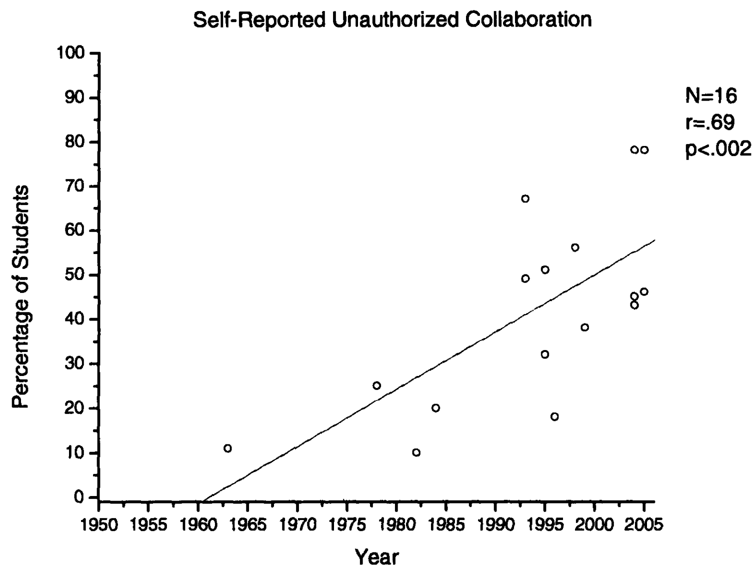

Self-Reported Exam Cheating (Using Crib Notes)
Total:
N=22
r=-.43
p<.04
w/o Goldsen:
N=21
r=-.18
p<.45
Percentage of Students
Year

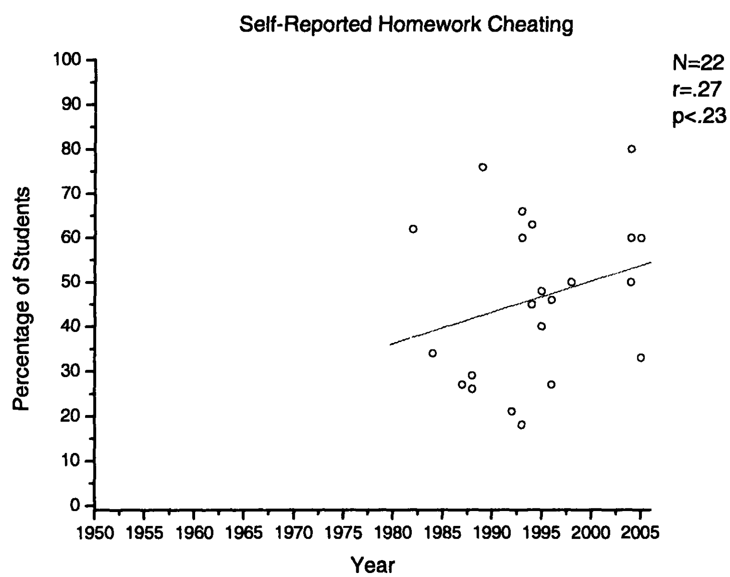

Self-Reported Plagiarism (Copy Material Without Footnoting)
N=14
r=-.14
p<.60
Percentage of Students
Year


Self-Reported Plagiarism(General)
N=26
r=-.37
p<.06
Percentage of Students
Year
0
10
20
30
40
50
60
70
80
90
100
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005


Self-Reported Plagiarism (Falsifying a Bibliography)
N=13
r=.02
p<.95
Percentage of Students
Year
0
10
20
30
40
50
60
70
80
90
100
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005


Self-Reported Plagiarism (Turn in Work Done by Another Student)
N=22
r=-.55
p<.007
Percentage of Students
Year
0
20
40
60
80
100
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005


Self-Reported Unauthorized Collaboration
N=16
r=.69
p<.002
Percentage of Students
Year


Self-Reported Homework Cheating
N=22
r=.27
p<.23
Percentage of Students
Year

Appendix E

Individual and Situational Factor Data

This appendix contains the breakdown of the individual and situational data used for our analysis of the correlates of cheating.

Author	Pub	N	Class				Sex		Marital Status		Frat/Sorority	
			1	2	3	4	M	F	No	Yes	No	Yes
Canning	56	48					89(18)	77(30)				
Canning	56	181					41(80)	42(101)				
Canning	56	70					24(33)	35(37)				
Hetherington	64	78					61(39)	39(39)				
Goldsen	60	2709	13(676)	23(630)	25(757)	27(746)					18(1750)	29(1059)
Harp &Taietz	66	1984	19(585)	42(502)	51(457)	50(385)					27(1100)	55(898)
Ackerman	71	227					50(114)	50(113)				
Smith et al	72	112					91(44)	97(68)				
Fakouri	72	154					24(49)	11(105)				
Erickson	74	113					54(50)	33(68)				
Smith	75	409					66(171)	66(231)				
Dienstbier	71	49					17(23)	36(25)				
Leming	80	152										
Diener	76	28										
Millham	74	91					20(50)	20(41)				
Kelly	78	591					24(236)	16(355)				
Heisler	74	123										
Singhal	82	364										
Baird	80	200	94(50)	98(50)	82(50)	88(50)						
Haines et al	84	380							63(288)	25(91)	52(53)	75(325)
Hawley	84	425										
Scheers & Dayton	87	184										
Scheers & Dayton	87	194										
Shaughnessy	88	361										
Tom and Borin	88	149										
Karlins	88	1374					.3(335)	6(331)				
Newhouse	82	118					80(52)	52(66)				
moffat	90	232	65(31)	64(42)	77(57)	88(102)						
Partello	93	34	6(34)									
May and Lloyd	93	177										
Huss	93	220					50(78)	40(142)				
Faulkender	94	600					59(266)	53(367)				
Davis	94	2143					61(675)	43(1478)				
Roberts	98	422					25(211)	35(211)				
Brown	95	207										
Tang	97	282					48(130)	33(152)				
Newstead et al	96	928					28(400)	18(528)				
Genereux et al	95	365					85(181)	79(184)				
Dawkins	104	658					46(298)	38(391)				
Blankenship et al	100	284					32(118)	30(166)				
Jensen	102	490										
Nathanson	105	770					5.2(270)	3.6(500)				
Nathanson	105	250					3.2(95)	4.5(155)				
Bowers	64	579					69(197)	59(236)			60(88)	72(325)
McCabe	93	2240					70(608)	70(1100)			67(339)	84(1376)
McCabe	97	6909										

Author	Pub year	N	Race			Social Deviance		Religion			
			Cauc	Black	Asian	Yes	No	Strong	Avg	Non	Atheist
Canning	1956	48									
Canning	1956	181									
Canning	1956	70									
Hetherington	1964	78									
Goldsen	1960	2709									
Harp &Taietz	1966	1984									
Ackerman	1971	227									
Smith, et al	1972	112						0.523	24	57	
Fakouri	1972	154						91	174	228	
Erickson	1974	113						27	64		
Smith	1975	409						55(49)	51(125)	61(174)	45(54)
Dienstbier	1971	49									
Leming	1980	152									
Diener	1976	28									
Millham	1974	91									
Kelly	1978	591									
Heisler	1974	123				74(62)	54(61)				
Singhal	1982	364									
Baird	1980	200									
Haines et al	1984	380									
Hawley	1984	425									
Scheers & Dayton	1987	184									
Scheers & Dayton	1987	194									
Shaughnessy	1988	361									
Tom and Borin	1988	149									
Karlins	1988	1374									
Newhouse	1982	118									
moffat	1990	232									
Partello	1993	34									
May and Lloyd	1993	177									
Huss	1993	220									
Faulkender	1994	600									
Davis	1994	2143									
Roberts	1998	422									
Brown	1995	207									
Tang	1997	282	39(200)	39(82)							
Newstead, et al	1996	928									
Genereux et al	1995	365									
Dawkins	2004	658									
Blankenship et al	2000	284									
Jensen	2002	490									
Nathanson	2005	770	2.7(331)	1.4(145)	5.2(293)						
Nathanson	2005	250	1.3(80)	3.5(58)	6.2(113)						
Bowers	1964	579									
McCabe	1993	2240									
McCabe	1997	6909									

Author	Pub	N	Major				GPA			Level of Education		
			Bus	Sci	Eng	Hum	Low	Med	High	High S	Under	Grad
Canning	1956	48										
Canning	1956	181										
Canning	1956	70										
Hetherington	1964	78										
Goldsen	1960	2709										
Harp &Taietz	1966	1984		33(761)	49(625)		41(618)	43(703)	34(663)			
Ackerman	1971	227										
Smith, et al	1972	112										
Fakouri	1972	154					88(24)	12(24)				
Erickson	1974	113					74(23)	24(34)	22(27)			
Smith	1975	409										
Dienstbier	1971	49										
Leming	1980	152										
Diener	1976	28										
Millham	1974	91										
Kelly	1978	591										
Heisler	1974	123										
Singhal	1982	364			56(364)		62(180)	55(180)				
Baird	1980	200								84(200)	76(200)	
Haines et al	1984	380										
Hawley	1984	425					23 (17)	23 384)	9 (22)			
Scheers & Dayton	1987	184					86 (39)	74 (39)	36(110)			
Scheers & Dayton	1987	194					47(42)	37(42)	23(110)			
Shaughnessy	1988	361	36 (33)	24 (100)		32(228)				48(361)	32(361)	
Tom and Borin	1988	149	49(149)									
Karlins	1988	1374										
Newhouse	1982	118										
moffat	1990	232	87(38)	60(20)		75(88)						
Partello	1993	34								82(34)	6(34)	
May and Lloyd	1993	177										
Huss	1993	220										
Faulkender	1994	600										
Davis	1994	2143								77(2143)	49(2143)	
Roberts	1998	422										
Brown	1995	207										80(207)
Tang	1997	282										
Newstead, et al	1996	928		31(199)	26(210)	17(141)						
Genereux et al	1995	365									48(560)	12(133)
Dawkins	2004	658										
Blankenship et al	2000	284										
Jensen	2002	490								89(229)	60(261)	
Nathanson	2005	770		2.7(293)		4.4(254)						
Nathanson	2005	250		3.5(85)		5.9(117)						
Bowers	1964	579										
McCabe	1993	2240										
McCabe	1997	6909										

Appendix F

8.02 Electricity and Magnetism Spring 2006 Survey

This appendix contains the cheating and homework copying survey administered to the 8.02 Spring 2006 class.

We are conducting a short survey on the prevalence, factors, and consequences of homework copying within 8.01/8.02. Please do not write any identifying information on the answer sheet(s). Your honest self-assessment will help us to improve the student experience in 8.01/8.02 both now and in the future. Please bubble in the appropriate letter(s) on your answer sheet. Page 3 contains several free response questions; please write any answers on the page and submit it with the bubble sheet.

How frequently do you believe the following occur on the MIT campus?

		Never	Very Seldom	Seldom	Often	Very Often
1	Plagiarism on written assignments	A	B	C	D	E
2	Inappropriate sharing in group assignments	A	B	C	D	E
3	Cheating during tests/exams	A	B	C	D	E

In the past year, how often have you engaged in any of the following behaviors at MIT?

		Never	Once	More than once	N/A
4	Working on an assignment with others when the instructor asked for individual work	A	B	C	D
5	Getting Q/A from someone who took the test	A	B	C	D
6	Helping someone else cheat on a test	A	B	C	D
7	Fabricating or falsifying lab data	A	B	C	D
8	Copying from another student during a test or exam without his or her knowing it	A	B	C	D
9	Receiving unpermitted help on an assignment	A	B	C	D
10	Turning in a written homework assignment partly copied from another student's work, a "bible", a website, etc	A	B	C	D
11	Turning in an electronic homework assignment partly copied from e.g. another student's work, an account set up for getting answers, a web site, etc	A	B	C	D
12	Using false excuse to obtain extension on due date	A	B	C	D
13	Turning in work done by someone else	A	B	C	D

How serious is this cheating?

		Not Cheating	Trivial	Moderate	Serious
14	Working on an assignment with others when the instructor asked for individual work.	A	B	C	D
15	Getting Q/A from someone who took the test	A	B	C	D

16	Helping someone else cheat on a test	A	B	C	D
17	Fabricating or falsifying lab data	A	B	C	D
18	Copying from another student during a test or exam without his or her knowing it	A	B	C	D
19	Receiving unpermitted help on an assignment	A	B	C	D
20	Turning in a written homework assignment partly copied from another student's work, a "bible", a website, etc.	A	B	C	D

		Not Cheating	Trivial	Moderate	Serious
21	Turning in an electronic homework assignment partly copied from e.g. another student's work, an account set up for getting answers, a web site, etc.	A	B	C	D
22	Using false excuse to obtain extension on due date	A	B	C	D
23	Turning in work done by someone else	A	B	C	D

		None	<10%	10-20%	20-40%	>40%
24	In 8.01, for what percentage of the problems on your written homework did you submitted solutions copied from someone else's work(including a "bible", website, etc.)	A	B	C	D	E
25	In 8.01, for what percentage of the problems on your electronic homework did you submitted solutions copied from someone else's work(including a "bible", website, etc.)	A	B	C	D	E
26	How much homework did you copy in your high school science course?	A	B	C	D	E

		Problems were too easy	Problems were too difficult	Problems took too much time	Lack of time due to other classes	Don't care about learning physics
27	If you copied homework/MasteringPhysics answers in 8.01/8.02, please indicate your reasons (Leave blank if you have never copied homework problems):	A	B	C	D	E

		Answers were not easily available	Morally its not right	Not fair to other students	I wanted to learn physics	Class policy says no copying
28	If you did not copy homework or MasteringPhysics answers in 8.01/8.02, please indicate your reasons:	A	B	C	D	E

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

29	I don't feel that copying in 8.01/8.02 is an indication of future unethical behavior	A	B	C	D	E
30	Copying is really not that serious when its confined to homework	A	B	C	D	E
31	Cheating in 8.01/8.02 is almost exclusively confined to the homework	A	B	C	D	E
32	Most students copy at least one written or electronic homework problem per assignment in 8.01/8.02	A	B	C	D	E
33	Regular copying on each homework assigment is limited to a small section of the class	A	B	C	D	E
34	I would never consider cheating on an exam	A	B	C	D	E

	An organization has recruited you for your dream career. They can allow you to remain at MIT for only two years, but will provide you with your choice of tutors:	Degree Tutor-will help you earn enough academic credit to get your degree, but you will learn little	Teacher Tutor-will help you learn 4 years material, but you will receive little academic credit.
35	Which will you choose?	A	B

		"Mastery Learning": Motivated to master the concepts of Mechanics/Electromagnetism	"Goal Oriented": Must complete this class because it is a degree requirement
36	On balance, which of these are your motivations for 8.01/8.02?	A	B

		Top	Next to Top	3rd	4th	5th
37	Of the current courses you are taking, where is physics in intrinsic interest to you?	A	B	C	D	E

		Science	Engineering	Management	Humanities	Other
38	Which likely school will your major come from?	A	B	C	D	E

		Nahn (#1)	Surrow (#2)	Feld (#3)	Greytak (#4)	Vuletic (#5)
39a	Which 8.01 section were you in?	A	B	C	D	E

		Rappaport (#6)	Dourmas. (#7)	N/A
39b	Which 8.01 section were you in?	A	B	C

40 **If you copied written homework in 8.01/8.02, please explain the method used (Leave blank if you did not copy):**

41 **If you copied electronic homework in 8.01/8.02, please explain the method used (Leave blank if you did not copy):**

42 **Please elaborate if you have any other reasons for copying homework (question 27).**

43 **Please elaborate if you have any other reasons for *not* copying homework (question 28).**

44 **Do you have any further comments with regards to this survey?**

Thank you for your time in completing this survey. Results of the class survey will be presented soon. For questions or comments on the contents of the survey, please contact David Palazzo at dpalazzo@mit.edu.

Appendix G

8.02 Survey Results and Free Response Answers

This appendix contains the results of the cheating and homework copying survey administered to the 8.02 Spring 2006 class.

(%) are national averages

How frequently do you believe the following occur on the MIT campus?

		Never	Very Seldom	Seldom	Often	Very Often
1	Plagiarism on written assignments	13.67(2)	32.81(22)	35.94(45)	13.28(31)	4.30(11)
2	Inappropriate sharing in group assignments	6.64(2)	13.67(14)	31.64(34)	32.81(34)	13.28(16)
3	Cheating during tests/exams	30.47(6)	50.39(37)	14.45(35)	3.52(16)	.78(7)

In the past year, how often have you engaged in any of the following behaviors at MIT?

		Never	Once	More than once	N/A
4	Working on an assignment with others when the instructor asked for individual work	48.44(55)	10.94(17)	18.75(21)	17.97(7)
5	Getting Q/A from someone who took the test	88.67(67)	3.52(16)	2.73(14)	3.91(3)
6	Helping someone else cheat on a test	95.7(85)	.39(7)	0(4)	1.56(3)
7	Fabricating or falsifying lab data	70.31(60)	14.45(8)	3.91(6)	9.38(26)
8	Copying from another student during a test or exam without his or her knowing it	96.48(86)	.78(7)	.39(4)	.78(3)
9	Receiving unpermitted help on an assignment	67.19(70)	10.55(14)	14.55(11)	5.47(5)
10	Turning in a written homework assignment partly copied from another student's work, a "bible", a website, etc	32.81	17.58	45.70	1.95
11	Turning in an electronic homework assignment partly copied from e.g. another student's work, an account set up for getting answers, a web site, etc	55.86	18.75	21.88	1.56
12	Using false excuse to obtain extension on due date	87.5(80)	6.25(11)	2.73(6)	.39(3)
13	Turning in work done by someone else	85.94(93)	4.69(3)	5.47(2)	.78(2)

How serious is this cheating?

		Not Cheating	Trivial	Moderate	Serious
14	Working on an assignment with others when the instructor asked for individual work	5.47(23)	52.34(44)	33.98(26)	4.30(8)
15	Getting Q/A from someone who took the test	1.56(13)	8.98(20)	32.81(31)	52.73(36)
16	Helping someone else cheat on a test	.78(6)	.78(7)	8.98(20)	85.94(67)

17	Fabricating or falsifying lab data	3.13(9)	11.72(26)	29.69(36)	52.34(29)
18	Copying from another student during a test or exam without his or her knowing it	1.56(5)	1.17(4)	7.03(12)	86.72(79)
19	Receiving unpermitted help on an assignment	3.91(18)	30.08(35)	47.66(33)	16.02(14)
20	Turning in a written homework assignment partly copied from another student's work, a "bible", a website, etc.	5.08	37.69	37.5	16.02

		Not Cheating	Trivial	Moderate	Serious
21	Turning in an electronic homework assignment partly copied from e.g. another student's work, an account set up for getting answers, a web site, etc.	3.91	41.8	34.77	16.02
22	Using false excuse to obtain extension on due date	5.08(16)	26.95(26)	44.92(34)	17.97(24)
23	Turning in work done by someone else	1.56(6)	3.13(6)	22.66(18)	66.41(70)

		None	<10%	10-20%	20-40%	>40%
24	In 8.01, for what percentage of the problems on your written homework did you submitted solutions copied from someone else's work(including a "bible", website, etc.)	33.59	33.59	15.23	5.08	3.52
25	In 8.01, for what percentage of the problems on your electronic homework did you submitted solutions copied from someone else's work(including a "bible", website, etc.)	51.56	26.95	7.03	3.52	1.56
26	How much homework did you copy in your high school science course?	73.05	13.67	2.73	1.95	0.78

		Problems were too easy	Problems were too difficult	Problems took too much time	Lack of time due to other classes	Don't care about learning physics
27	If you copied homework/MasteringPhysics answers in 8.01/8.02, please indicate your reasons (Leave blank if you have never copied homework problems):	0.78	25.39	12.5	25.78	3.13

		Answers were not easily available	Morally its not right	Not fair to other students	I wanted to learn physics	Class policy says no copying
28	If you did not copy homework or MasteringPhysics answers in 8.01/8.02, please indicate your reasons:	2.34	16.41	8.98	35.94	3.52

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
29	I don't feel that copying in 8.01/8.02 is an indication of future unethical behavior	14.84	30.86	24.22	17.97	5.47
30	Copying is really not that serious when its confined to homework	8.59	28.13	27.73	23.83	4.3

31	Cheating in 8.01/8.02 is almost exclusively confined to the homework	29.69	37.5	15.23	7.03	1.95
32	Most students copy at least one written or electronic homework problem per assignment in 8.01/8.02	20.7	28.5	22.27	16.8	2.34
33	Regular copying on each homework assigment is limited to a small section of the class	11.33	26.56	25.39	21.88	5.47
34	I would never consider cheating on an exam	69.53	16.02	2.73	1.95	1.17

An organization has recruited you for your dream career. They can allow you to remain at MIT for only two years, but will provide you with your choice of tutors:	Degree Tutor-will help you earn enough academic credit to get your degree, but you will learn little	Teacher Tutor-will help you learn 4 years material, but you will receive little academic credit.
35 Which will you choose?	29.3	60.55

	"Mastery Learning": Motivated to master the concepts of Mechanics/Electromagnetism	"Goal Oriented": Must complete this class because it is a degree requirement
36 On balance, which of these are your motivations for 8.01/8.02?	31.64	55.47

		Top	Next to Top	3rd	4th	5th
37	Of the current courses you are taking, where is physics in intrinsic interest to you?	5.08	19.14	29.3	25.78	11.72

		Science	Engineering	Management	Humanities	Other
38	Which likely school will your major come from?	24.61	52.34	6.25	2.73	3.13

		Nahn (#1)	Surrow (#2)	Feld (#3)	Greytak (#4)	Vuletic (#5)
39a	Which 8.01 section were you in?	18.36	17.19	11.33	8.59	3.91

		Rappaport (#6)	Dourmas. (#7)	N/A
40	Which 8.01 section were you in?	3.52	5.86	11.33

Free Response Answers:

40 If you copied written homework in 8.01/8.02, please explain the method used :
5007-Many answers were online as part of previous assignments
2001-People in dorms
2020-Lets see, a friend had downloaded last semester's assignments, so we have a bible
1013-Went downstairs to a group working on the Pset and asked "you guys got #?". Then proceeded to ask questions how to do it while I copied the answer.
1017-Have someone explain their work then copy if I understand
2028-OCW, studied similar problems and used same equations
2032-OCW for 8.01. for 8.02 one of my friends downloaded last semester's hw solutions
6025-OCW
6028-Googling textbook problems sometimes works.
6034-I looked at a friends Pset when stumped, and used his methods while trying to do my own work.
6033-OCW
6032-If I get stuck on a problem, I would ask a friend for the equation I would need and back solve, or find a similar problem solution online and adapt
6038-Looked at a friends Pset.
6017-Looked at somebody's Pset
6014-I would look at someone else paper to see what they did and if I could not understand it they would explain it to me. I would not straight copy.
6013-OCW
2004-Friend
6001-I went to office hours and copied from my friends assignments
6003-I copied Pset answers from the T/As during office hours, they give us the answers because the Psets are too difficult.
6007-OCW
6046-Copy and review for understanding later
6051-Copied from peers
8009-Bible
3009-I asked for someone elses Pset and they gave it willingly
8010-Bible
8020-I copied last weeks pre lab because it was so hard and I couldn't figure it out.
8019-Used neighbors Pset.
8021-Too hard, not enough time because of other classes.
8025-OCW
unk-Simple copied someone elses work onto my paper.
Unk-Looked over friends Pset and if I didn't understand I would copy their work
Unk- I looked at how a problem was solved, saw if it made sense, and then altered it to my style of problem solving
unk-Looked at others HW
unk-Had a friend go through their approach and reasoning through each step
unk-Had anothers homework available to help when stumped

unk-I never copy material directly. I either ask the person who did the work what is going on or I try to figure out what is going on before I write anything down. I make sure I understand the material
unk-Looking at others problem sets or searching the net
unk-OCW
unk-tried it first, ranout of time, copied a friends, making sure I understood what I was copying.
Unk-I worked together with classmates to check answers and compare strategies.
Unk-by hand
Unk-Go to a friend and ask
Unk-There should be a clearer definition of copying
Unk-Discussed in group
Unk-Used others work as a guide
Unk-Friends

41 If you copied electronic homework in 8.01/8.02, please explain the method used:
2001-IM answers to each other
2002-Hacked the main frame
2020-in mastering physics in order to avoid losing unnecessarily large amounts of point on multiple choice I usually log into a friends account
1013-Same as 40
6025-Working in groups
6034-Asked a friend the answer to a MC question
6033-Friend
6018-Friend emailed me answers
6017-Signed into my friends account
6013-Friend
2004-Friend
6001-Friends
6046-Copying produces much higher grades than doing it on your own. Problems are much harder than exam stuff.
3007-Sharing passwords
3009-Friends
8019-IM
8025-Friends
unk- I would walk over and ask "how does this work" and walk back and try it again.
Unk-I think MP is supposed to be individual but Ive done it with others
Unk-Looked at friends
Unk-straight copying
Unk-Copy and paste, IM
Unk-Friend
Unk-Just got the answer from someone else.
Unk-From someone else
Unk-Ask others
Unk-Doing it as a group, or having someone email me the answers

42 Please elaborate if you have any other reasons for copying homework:
2002-We don't learn how to solve such hard problems
2020-mainly to get through my work, I have 5 Psets a week, but I only copy if I don't do work over the weekend, which is a surprisingly rare occurrence.
1013-Not enough time Sometimes the problems are just too hard and I don't know where to start.
6031-MIT doesn't have enough hours in the day. Sometimes sleep is more important than losing your sanity over a dumb problem.
6025-The Psets are extremely difficult and graded harshly, so to get the maximum points, it seemed necessary.
6034-Lack of time/sleep
6033-Learn more from looking at the right answer than not doing it.
6038-Don't understand the question
6017-Only when I was scrambling to do other work

6032-Sometimes problems are written so poorly or require application of concepts so obscure that only those who have the time to go to office hours have a clue about how to even start them
6013-I think it is a mix of too difficult and not enough time.
2004-I don't have time that week, we split up assignments, too trivial
6051-I copied because they were long and hard and I do not think they helped me learn
3007-I am not motivated to learn physics because I don't enjoy it and its not needed for my major.
3008-If I did, it would be because of sheer lack of time
8025-stress from other classes
unk-Because I cannot do it myself and didn't have enough time to attend office hours due to an illness, but didn't want to turn nothing in. The two classes I copy the most are 18.03 ad 8.02, but I always feel horrible when I do it, but I can't get everything done and I feel copying is a better alternative than having nothing.
Unk- Down to the wire trying to finish and I'm so tired I can't think, but will go back.
Unk-It is expected that you get a good grade on the homework,but some of the questions are harder than the exams.
Unk-Too hard, no one bothered to teach, would have done very poorly
Unk-hard, long, didn't help me learn the material
Unk-Not enough time, frustrated with how this class is taught, frustrated with MIT
Unk-Not interested, other work
Unk-Problems were too hard
Unk-it was late
Unk-Time constraint is the top reason. I don't think MP is that important, but it is a decent chunk of our grade.
Unk-Difficulty
Unk-Too late in the morning, no idea how to do.
Unk-Too hard, cant do it although I want to
Unk-Its easy, isnt even worth the algebra

43 Please elaborate if you have any other reasons for *not* copying homework:
2002-You don't know my mom
2020-I usually don't copy so I wont blow tests
6031-As much as I hate the core requirements of MIT, I fell better when I complete the assignments myself or with the aid of tutoring or office hours than when someone just gives you the answer. Even though I know I'll never use the material I am learning now, I like the sense of accomplishment I get.
6026-Most of the reasons given apply to me.
6028-Its probably as hard to cheat as to actually do the work.
6034-I try not to copy verbatim or without understanding cause I feel like its wrong/would hurt me in the end.
6032-If I copy I don't learn. I'm not a fan of TEAL, but I should at least develop a basic understanding of physics.

6038-Don't want to be suspended, risk spoiling my academic record.
6017-I think Psets help you learn and practice
2004-Integrity
6005-In addition to moral issues, I feel my own knowledge would be adversely affected.
6051-I did not copy MP because it was very helpful in teaching me the material.
3008-I don't copy, I need to pass 8.02 to graduate
8018-Copying is morally wrong and unfair
8019-Its lame
8021-I don't learn if I copy and that bothers me
8025-Its not good if you really want to learn
unk-In 8.02 there are always people aorund with whom to collaborate so its not necessary to use the internet.
Unk-I really, really, really want to understan physics!
Unk- I think its cheating
Unk-I want to learn it myself.
Unk-I feel that it is not right to copy homework
Unk-Didn't copy MP because I wanted to learn the material
Unk-I do want to learn but feel I am not given the time
Unk-to learn the material to do well on the exam
Unk-It doesn't teach you the material. Doing problem sets is the best way to learn
Unk-Morals, ethics
Unk-I would rather learn it myself or just go to office hours.
Unk-It is just as easy to have someone teach you the material
Unk-want to learn
Unk-if I know my friend worked really hard on it
Unk-Sometimes its so easy finding the answers is more work than actually doing it
Unk-If you copy, your screwed on the test

44 Do you have any further comments with regards to this survey?
5007-If you cant get to office hours, its sometimes very hard to get the Psets done, especially in weeks where the Pset is due the same day that many students have 2 tests.
1013-MIT students do their own work whenever possible, however, sometimes its unavoidable (to get reasonable hours of sleep)
2028-Labview data doesn't matter, so making up numbers isn't too bad, real data should never be falsified
2032-I feel that cheating is the most wrong thing ever. If I get the inkling that one of my colleagues is cheating, I will make it my personal business to the authorities to punish the unethical creature.
6031-I feel there are so many electronic resources available to us, it encourages us to look at past semester's data online to help us with current assignments. If OCW was cheating, it wouldn't exist

2004-TEAL stinks
6032-"unpermitted help" is a tricky phrase with OCW
6046-Quizzes make me learn w/o wasting time like Psets
3008-#35 was the toughest. #28 is extremely interesting from a philosophical standpoint
3009-I feel taking this survey is a waste of time, limiting our class time to do our problem solving session, these stresses are probably a lot of what causes people to copy in the first place.
8018-Not effective, people will lie
8021-Its not very accurate
unk-people are not going to tell you what is really going on!
Unk-Make the survey mandatory
Unk-Make the 8.02 Psets possible to do w/o having to look at someone elses work. Often I can't go to office hours, so I have no choice but to look at someone elses work.
Unk-Basically cheating on homework isnt bad because it only hurts you come test time. Test cheating is wrong.
Unk-this survey didn't distinguish between group collaboration and copying.
Unk-Both 8.01 and 8.02 encourage collaboration on problem sets and outside work. While I may copy, I always make sure I understand
Unk-The question about dream career is inane. Nobody would make that choice.