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Technology and Plagiarism in the University: Brief Report of a Trial in Detecting Cheating

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Abstract: College students exploit information technology to cheat on papers and assignments, but for the most part university faculty employ few technological techniques to detect cheating. This paper reports on a trial of software for the detection of cheating in a large undergraduate survey class. The paper discusses the decision to adopt electronic means for screening student papers, the techniques used, the outcome, strategic concerns regarding deterrence versus detection of cheating, and the results of a survey of student attitudes about the experience. The paper advances the thesis that easily-adopted techniques not only close a sophistication gap associated with computerized cheating, but can place faculty in a stronger position than they have ever enjoyed historically with regard to the deterrence and detection of some classes of plagiarism.

1. The Issue: Technological Asymmetry

University professors have been losing a technological arms race with their students over plagiarism for many years. Since the end of the days when term-papers and other assignments were hand-written, students willing to misrepresent others' work as their own have exploited an expanding array of tools. From the simple cutting-and-pasting from un-cited sources or each other's work, to the use of keyword-searchable collections of term papers available for purchase, students have at their disposal a broad palette of quite powerful techniques.

That these methods have become commonplace for students and notorious among their instructors has not led many faculty to employ commensurately sophisticated technologies for detection. A good deal of concern is now directed at the plagiarism crisis in universities: honor codes are being adopted or expanded, reports are being commissioned, and journalists are producing a stream of news stories. But in most cases, the techniques instructors actually use for identifying plagiarism and thereby deterring it remain frankly old-fashioned, unchanged for the most part from the good old days of pen-and-paper assignments. Even in cases where classes feature course web sites, electronic presentations, and other applications of contemporary technology, instructors typically fall behind their own students in degree of technological sophistication when it comes to matters of cheating. This gap in sophistication between students

and their instructors is one of many pressing issues created by the rapid evolution of information technology in the university.

This paper describes and discusses a classroom trial of pattern-matching software capable of detecting certain categories of plagiarism. This trial, at the University of California, Santa Barbara, was a collaboration between the professor, a research assistant, the campus Office of Instructional Development, and staff of the Office of the Dean of Students. It is part of a larger program of experimentation and development of classroom technology supported by the UCSB Center for Information Technology and Society. (For other reports, see www.cits.ucsb.edu). The paper describes the origins of the trial in dissatisfaction with traditional techniques, the approach to using cheating software, the results, considerations of the dual aims of deterring and detecting cheating, and future steps that will follow.

The thesis advanced here is that readily available technologies are capable of doing more than simply closing the sophistication gap between students and instructors. Their use can in some respects place faculty in a stronger position than they ever enjoyed historically, even in the days when cumbersome pen-and-paper assignments using printed rather than electronic sources meant cheating was more difficult and labor-intensive for students.

One of the conceits of technological advance has long been that the solution to any human costs of innovation is simply more innovation. But it is not often that social or moral problems created by use of technology can be remedied well by the use of additional technology. Plagiarism may be one exception. The reason is straightforward. The fundamental technological problem we see is a simple asymmetry in the use of existing information technology. Virtually all students build, manipulate, and can share electronic versions of their course work, but they then submit to their instructors only paper copies. Those paper copies then narrowly circumscribe instructors' power to identify the process that went into their creation. So long as this asymmetry exists, students will have the upper hand in cheating, regardless of whatever exhortations and lessons in honesty are directed at them by their universities. The simple transition to electronic submission of student work rather than the transfer of paper is the foundation for remedying this imbalance as well as for other pedagogic advances.

2. The Failure of Traditional Approaches

It now seems clear that the tepid response of most universities to students' cheating opportunities constitutes a serious problem. The nationwide conversation about what appears to be an epidemic in academic dishonestly continues unabated. A study by the Center for Academic Integrity found that almost 75% of college students own up to some form of academic dishonesty. And the level of cheating is on the rise: from the same study, in 1963 11% of students at medium to large universities said they collaborated on assignments when it was expressly not permitted and, that percentage increased to 49% by 1993. (Groark, Oblinger, Choa 2001). Additionally, in a survey commissioned by Knowledge Ventures, more than 90% of academic administrators and faculty said that integrity is an issue on their campus. (Groark, Oblinger, Choa 2001). A number of institutions have in turn adopted honor codes for the first time or revised existing documents in response. (McCabe, 2001). However, the problem

continues in the face of traditional responses, and the Internet in particular has added a level of complexity to the problem to which universities are struggling to develop effective responses.

Of course many categories of cheating exist, and the demands they create on instructors vary somewhat. We are concerned here with cheating on term papers in large survey classes. In particular, we are concerned with the sharing of work between students, whatever its origins. Large introductory classes are paradigmatic of some of the cheating problems for a number of reasons. For one, assignments are often graded by more than one person, making it difficult to check for similarity among papers. Students can readily surmise that no one person will be able to read hundreds of papers and so be in a position to identify duplicate work. Also, because so many students take these large classes every year, and because assignments are often at a fairly basic level, the potential supply of plagiarizable sources is great. Paragraphs or even pages of material may be clipped with ease from web sites. Worse, complete papers may be available from classmates, fellow athletes, roommates, the Greek system, and the wide array of Internet-based term-paper vendors.[1]

To explore remedies to these problems we chose a large course on American Government and Politics taught by one of the authors. It is typical of introductory surveys, enrolling from 350 to 600, depending on the term. It attracts a wide range of students who take it as a General Education course, a gateway course into the political science major, or as a prerequisite for a state teaching credential. The course usually requires that students submit one term paper of about ten pages or, in some years, two analytic essays of five pages each.

It is these written assignments, in the context of a large, sectioned class, with multiple teaching assistants, that are the focus of our plagiarism concerns. In the past, faculty offering this course have employed a number of approaches in varying combinations to thwart some categories of academic dishonesty. These include:

- Highly specific, directed, term paper questions intended to reduce the probability that students are able to find or purchase complete papers meeting the requirements of the assignment;

- Rotation of term paper assignments every year or two to confound the collection of usable term paper files by fraternities or other student groups;

- Assignment of different term paper questions to each Teaching Assistant's students, so that opportunities for cross-TA sharing of papers are reduced;

- Selective testing of specific phrases from suspicious-looking papers using Internet search engines to look for possible sources of material.

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[1] A tiny sample of these paper mills includes Cheathouse.com (formerly the Evil House of Cheat), EssaysOnFile.com, GeniusPapers.com, LazyStudents.com, MightyStudents.com, SchoolSucks.com, and Termpapersrus.com.

These techniques are at the very best modest in their power to detect and deter cheating. Our conclusion from many years in this course is the same as that of many professors in other classes: these offer little promise in the face of the powerful tools available to students. In some cases these techniques are difficult to apply and can even compromise pedagogic quality, such as in the case of supplying narrowly crafted questions or varying assignments across Teaching Assistants.

For several years, some faculty teaching this course, including one of the present authors, have employed a rudimentary electronic technique for identifying gross cases of duplicate material in papers across Teaching Assistants. We have required each Teaching Assistant to enter into a spreadsheet several phrases from every student's paper. These might, for example, be the last five words in the first and last paragraphs, or the first words in the second sentence of particular paragraphs, or some other varying algorithm. With these spreadsheets in hand, comparisons can then be made across students using simple spreadsheet functions. Papers flagged by this technique as sharing phrases are then read by hand. This technique is enormously labor-intensive, and is likely only to detect unsophisticated, large-scale copying between two or more papers. It is easily defeated by students who are diligent in making slight modifications between plagiarized papers, and our experience in this class is that students submitting shared work literally always make slight changes throughout in order to disguise the duplication.

Despite its severe limitations, this technique has consistently identified an average of one case of plagiarism each time it is employed in this course. The fact that such a loose net catches some instances of cheating has been unsettling, since it implies that many other instances of cheating are likely going undetected.

3. Electronic Submission of Papers as the Foundation

The experiment with a nominal electronic comparison of tiny samples from student papers using spreadsheet functions made clear how desirable it would be to have the full text of every student's paper available electronically. At that point, a world of opportunities would open. In theory, the electronic text of a student paper can be compared with other students' work from the class in question, with historical archives of past papers, with papers of other professors including those at other universities, and in fact with any electronically searchable file, including all those on the open Internet.

Indeed, in recent years a number of products have become available to assist in this kind of paper comparison. One approach is the pattern-matching or comparison engine that runs on a local computer at the university. WORDCheck is a commercial example costing at the time of this writing between $100 and $1,000, depending on the size of the installation. Some faculty have written their own utilities for comparing student work, since the basic function of comparing text between files is so simple technically. The best-known case occurred at the University of Virginia, when in 2001 physics professor Lou Bloomfield found a hundred and fifty-eight papers with matching phrases from an introductory class. His pattern-matching software eventually resulted in the dismissal of 45 students and the revocation of three degrees. ("U of Virginia Hit by Scandal over Cheating", New York Times, May 10, 2001). Another approach to comparing papers involves commercial services to whom instructors may submit student papers. Some of

the more popular examples are Turnitin.com, Eve2, Copycatch, and Paperbin.[2] In all cases, the key that opens the door to this room full of opportunities for detecting and deterring plagiarism is simple: replacing the physical submission of paper documents with electronic submission.

For our trial in the American Government and Politics course, we prepared a simple file-uploading web page connected to the course web site. Here students ready to submit their papers entered their name, student identification number, e-mail address, teaching assistant's name and the file name of their paper. Figure 1 shows this screen. A 'Submit-Your-Paper" button, modeled after the check-out functions at online retailers, then transferred the student's paper file to our host computer, where it was logged, time-stamped, and renamed using a standardized naming convention we adopted for the course. Students received a pre-submission verification notice of the information they had entered and the name of the file they were about to submit, and a post-submission confirmation notice that we had received their paper.

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[2] Questions have been raised about violation of students' privacy and intellectual property rights in the cases of commercial paper comparison services. Although a number of educators and schools continue to find this objectionable, the prevailing view at this point seems to be that this practice is ethically acceptable and we agree within certain constraints. As for intellectual property concerns, the primary purpose of course work is not commercial gain but fulfillment of course requirements, so expectations of intellectual property rights are not high among undergraduates. Nonetheless, whatever intellectual property value might inhere in a written work is in no way diminished by a technique of private comparison with the work of others. Indeed, it might be argued that a procedure that validates student work as original could enhance intellectual property value. Privacy concerns are related. High standards for privacy are necessary for both school officials and their contractors.
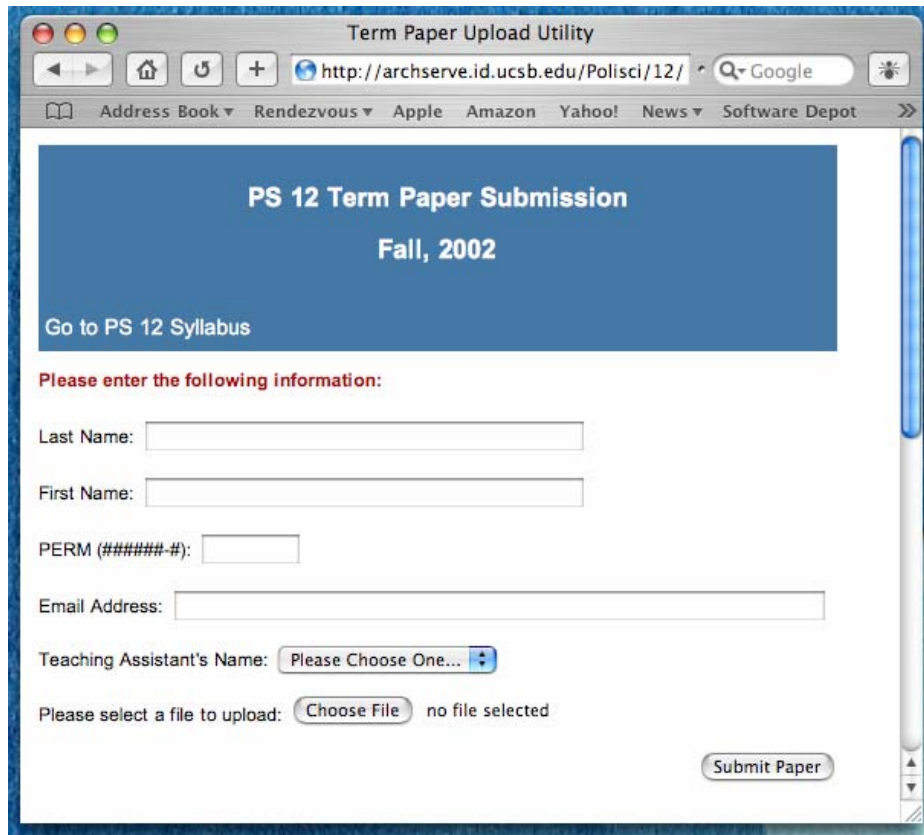
Figure 1. Term paper submission screen.

4. Analysis and Outcome

For analyzing the 590 papers students submitted, we adopted Copyfind 2.1, the freeware utility developed by Lou Bloomfield of the University of Virginia.[3] This utility makes pair-wise comparisons between papers using phrases of whatever length the instructor chooses. The first step in the analysis is the parsing of each paper into a list of every phrase of some defined length.

As an example, consider a paper containing the following sentences: *"Instructed delegate representation is an approach to democracy in which elected officials follow the expressed wishes of their constituents. In contrast to trustee representation, they set aside their own expertise, information, and judgments..."*

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[3] See http://plagiarism.phys.virginia.edu/Wsoftware.html

Disassembled into every possible sequential three-word phrase, this text produces a list of phrases beginning as follows:

> *Instructed delegate representation*
> *delegate representation is*
> *representation is an*
> *is an approach*
> *an approach to*
> *etc.*

Broken into fifteen-word phrases, this text produces a list beginning as follows:

> *"Instructed delegate representation is an approach to democracy in which elected officials follow the expressed*

> *delegate representation is an approach to democracy in which elected officials follow the expressed wishes*

> *representation is an approach to democracy in which elected officials follow the expressed wishes of*

> *etc.*

Each paper is parsed into a complete list of phrases in this way by Copyfind. Comparison between two papers is then a simple matter of counting the number of identical phrases that appear anywhere on two papers' lists. This technique therefore can identify identical phrases appearing in different places in the papers. The choice of phrase length to use in running the comparison is a simple optimization problem. Set the phrase length too short and the number of non-meaningful matches between papers will be too high, and set it too long and otherwise identical phrases in which students have altered just one word will be rejected as different. We approached the problem empirically by making multiple runs varying the phrase length, and we do not report the phrase length in this document so that this important piece of information does not reach students.

With these lists of phrases produced, the utility then simply makes all possible pair-wise comparisons. Our set of 590 papers produces 173,755 possible paper-pairs. Despite the large number of phrases in each paper and the large number of pairs, running the set required only about five minutes of time on a dual 800 MHz PowerMac G4 running MacOS X 10.2.1.

The result of the analysis is a number for each pair of papers that indicates how many phrases appear in both. Under any but the longest phrase length, literally every paper shared some substantial number of phrases with every other paper, since many students use stock phrases or idioms, arrive at similar sentences, begin paragraphs in similar ways, or quote the same source material here and there. Several hundred matching short phrases between ten-page papers is not unusual in the absence of plagiarism. But a pair of plagiarized papers – even those sharing just a few paragraphs with each other – stand out with a large spike in the number of matching phrases, reaching 500 or more matches.

These spikes in the number of matches indicates possible plagiarism. In our 590 papers, we found one pair and one triple of papers with vastly greater than the baseline number of random matching phrases. We then read these papers by hand and confirmed the presence of plagiarism. In the pair, roommates' papers shared an identical section amounting to about 20% of the paper, appearing at the end. This represented a moderately severe but unequivocal case of plagiarism. One student confessed in this case to taking material from his roommate's paper without the roommate's knowledge. The plagiarizing student was given an F in the course by the instructor and was suspended from the university for two quarters by the campus Student Conduct Committee.

In the other case, three papers shared massive verbatim text, running to about 90% in one pair. Two of the students involved admitted using the work of the third student while it was in the possession of a fourth student, who had been given the original paper to proofread. In this case, three students were suspended from the university for two quarters: both plagiarizing students and the intermediary, who was convicted of aiding and abetting their plagiarism.

5. Strategy of Disclosure: Deterrence or Punishment?

Having the capacity to compare student papers thoroughly raised an important question about the purpose of detecting plagiarism. In general, the apprehension of rule-breakers serves two social purposes: it punishes transgressors and it deters some people from proscribed behavior. The way that rule-enforcement activities are publicized may affect the balance that is struck between punishment and deterrence. If members of a society are completely unaware that detection and punishment of rule-breaking is occurring, little or no deterrent effect is accomplished. At the same time, where deterrence is perfect, then no punishment will occur. We deliberated at some length about whether to reveal to our students the nature of the efforts we would make in detecting cheating.

We surmised that a full disclosure to students would likely have a very powerful deterrent effect. Much of the literature on plagiarism written by educators and other scholars endorses a strategy of deterrence in all cases, and it would seem to recommend full disclosure. (Stoerger, 2002) In our case, we anticipated that the deterrence offered by disclosure of our software would likely extend to students who might be habitual or committed cheaters in other classes, but who would recognize that their odds of detection in this particular class would be extremely high – perhaps 100%. We therefore expected that if we disclosed fully we would, ironically, be likely to catch no one in the act of cheating.

We also anticipated a different effect, namely that the more information we revealed about our techniques the more crafty a few students might be in attempting to disguise efforts at plagiarism. In particular, knowing or guessing the phrase length used in our comparison would open a back-door to evading the software, though at the cost of considerable effort. At the same time, we realized that not revealing our technique would forfeit some of the deterrence, especially for students who might be causal, infrequent, or non-committed cheaters.

Our goal was *to deter students directly but also to detect and punish any cases of the most negligent or incorrigible cases of cheating*. We therefore adopted a middle strategy between full

disclosure and complete concealment. We call this soft-deterrence, and it worked as follows. In addition to several standard written and oral exhortations to students about plagiarism rules and obeying them, the term paper assignment included a warning that the instructor was "*on the lookout for students submitting papers that are essentially the same or that share sections*."

Students received this same warning orally in lecture, along with a customary statement about the penalties for cheating, which include possible suspension. Students therefore had at their disposal several warnings about plagiarism in this class, definitions and resources defining it and helping them avoid inadvertent plagiarism, and then the extra written and oral warnings specifically about the type of plagiarism that the instructor would be looking for on this particular assignment. All this took place in the context of instructions that papers would be submitted electronically. We stopped short, however, of explaining the means by which we would "be on the lookout."

Our intention was that this thorough set of warnings would serve to deter casual cheaters but not committed or foolhardy ones.   We likened this to an announcement that police would be out in force to detect speeders over a holiday weekend, but without an indication of just where radar traps might be located.

Our outcome of two cases of plagiarism strikes us as an endorsement of the soft-deterrence strategy. We can say with assurance that of our 590 students only these five were involved in sharing text with one another. We can also say with assurance that no two students used any common source such as a file copy of a paper or a commercial paper, since these would have appeared in our analysis as shared papers (though the source would be unknown to us). This strikes us impressionistically as a somewhat lower overall level of cheating than we would have expected in a class this large without the announcement and warnings and whatever inherent deterrent effect the electronic submission itself might have had.

In order to learn about students' reaction to this process, we included three new measures in the standard course-evaluation survey given to students on the last day of class, several days after they had submitted their term papers.   The first inquired about how students liked electronic submission of their papers compared with the traditional technique of turning in a printed copy. Students were given a seven-point feeling thermometer in which the middle score indicated they had no preference between electronic and paper submission, one end of the scale indicated a strong preference for submitting electronically, and the other end a strong preference for submitting the traditional way.   This permitted students to express a preference for either, indicate how strong that preference is, or express no preference.

The results show that about three quarters of students either prefer electronic submission or are indifferent, with the remaining quarter preferring traditional physical submission of papers. Specifically, 57% of students favored electronic submission, 15% reported no preference, and 28% favored traditional submission. On the seven-point scale, the modal response was a score of 7, which represented the strongest level of preference for electronic submission.   As this was the first trial of this technique in this course, and for a large majority of students was probably the first experience of submitting any college paper this way, we interpret these results as a quite strong level of student acceptance.

We asked two questions about whether students felt any deterrent to cheating from the instructor's exhortations in class and from the use of the electronic submission technique. We interpret the results with a grain of salt for two reasons. First, the findings of any survey inquiring about illicit activity are to be read with caution. Second, the survey asked students to consider a counterfactual question about their own behavior, namely whether they might have been more inclined to cheat under other course circumstances. Such hypothetical questions are far less reliable in surveys that are straightforward factual questions.

The first question posed the following. *"Students are often tempted to borrow parts or all of a paper from another student. Did the warnings that were given in this course that the instructor would be on the lookout for shared papers have any effect on you?"* A seven-point scale permitted answers ranging from "no effect" to "kept me from borrowing." (Note that we did not differentiate among "no effect" answers between situations where a student cheated despite the warning and where a student would not have cheated regardless of the warning.)

The results of this question are striking: 66% of students reported that the warning had at least some effect on them. Over a quarter of students – 27% - chose the strongest category of response indicating that the warning prevented them from borrowing work from another student. Figure 2 shows the tri-modal response.
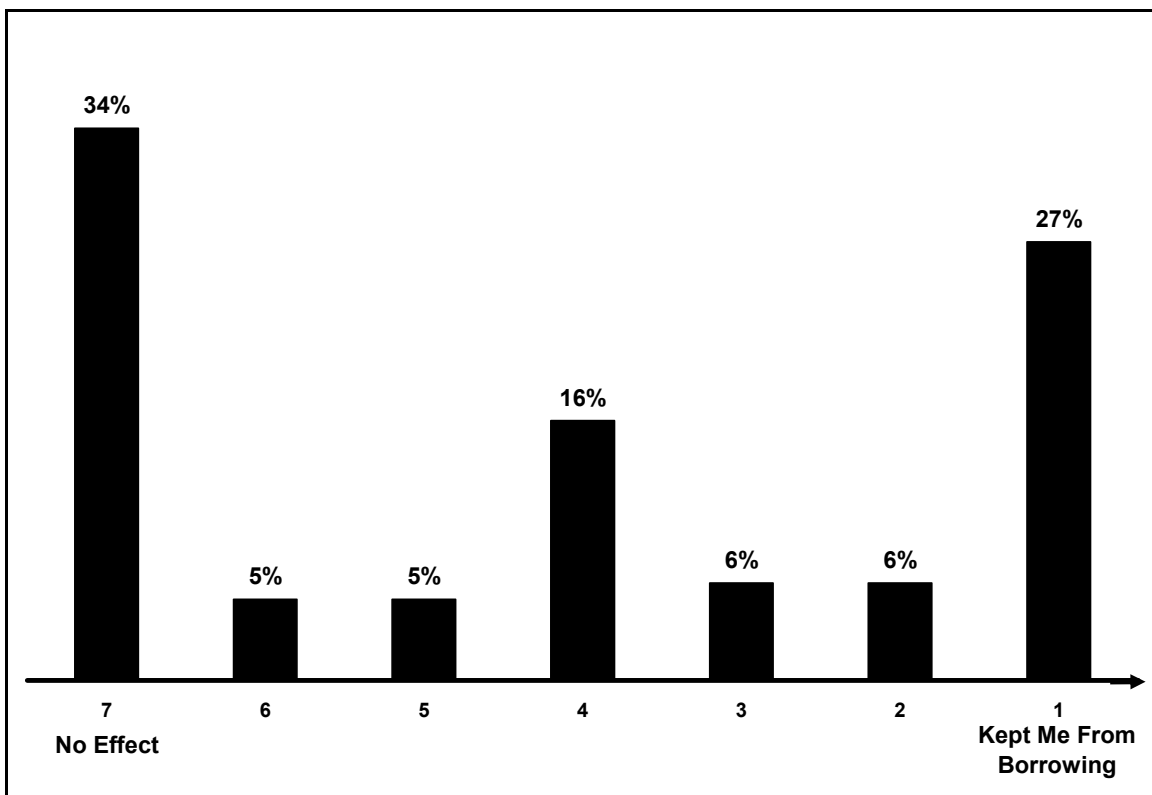

Figure 2. Self-reported effect of instructor warning on propensity to cheat

The second deterrence question addressed the electronic submission procedure. It asked: *"What about the fact that you submitted the paper electronically – did this have any effect on whether you decided to borrow parts or all of a paper from another student?"* Response distribution here shows the same overall shape, but with substantially more students reporting "no effect" and fewer – just 15% - saying that this technique kept them from borrowing. Figure 3 shows the responses.
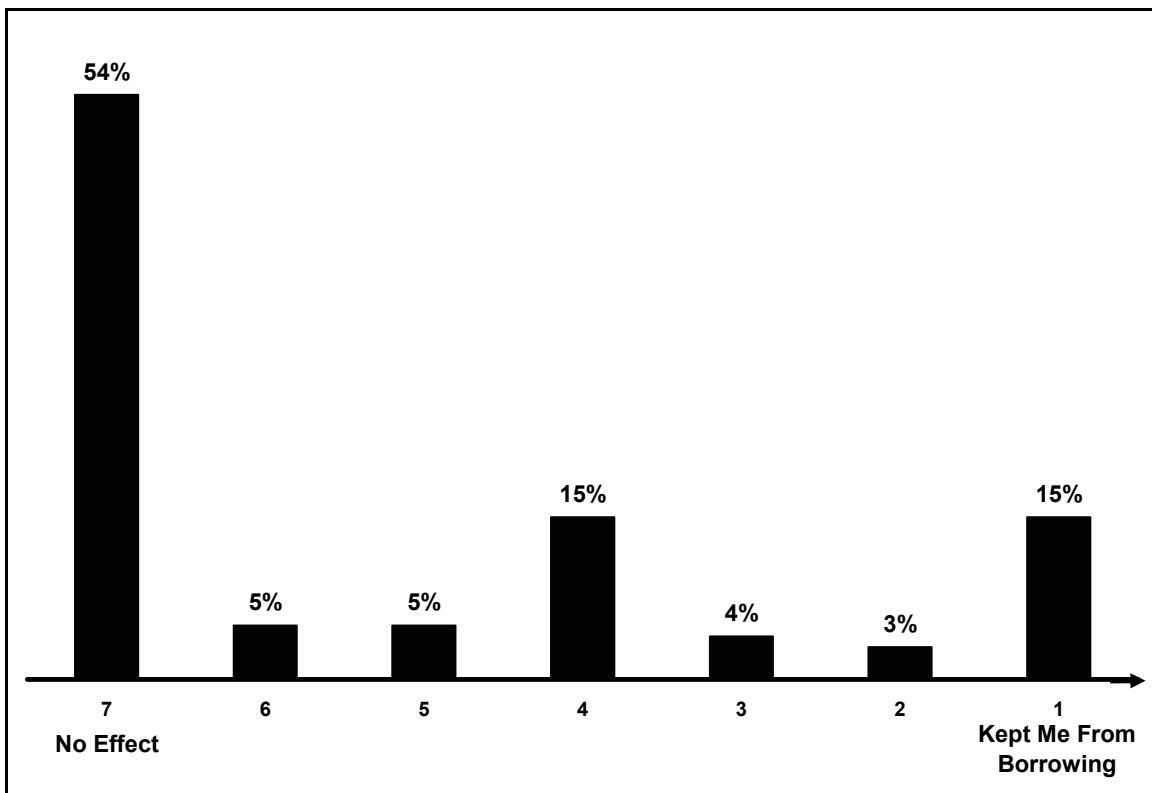

Figure 3. Self-reported effect of electronic submission on propensity to cheat

In this case as in Figure 2, the question elicited some indecision, which is reflected in the central mode at the mid-point of the scale. We interpret this and the other responses near it as students unclear about the situation and wishing to register uncertainty about whether they were affected by the arrangements in the class. This strikes us as unsurprising. Something between a large plurality and a small majority are simply determined (not to cheat or to cheat), a non-trivial minority of up to a quarter are likely tempted to cheat but can be deterred, and the rest – a substantial number – are up for grabs morally.

The satisfying lesson we are tempted to draw from these data are that the moral authority of exhortation against cheating is at least as strong and probably stronger than the implicit threat of detection from electronic submission. These are very simple measures of a complex phenomenon, however, and are best considered suggestive in a preliminary way. We conclude

that they are supportive of our strategy: it appears that the approach we used in this course had some deterrent effect along with its proven capacity actually to detect cheating.

6. A Few Surprises, Pleasant and Otherwise

We enjoyed two unexpected benefits from this trial of plagiarism-detection technology. First, having a password-protected, central repository of all student papers proved useful in several ways aside from cheating detection. The professor had ready access to student work and could browse papers at will. Also, Teaching Assistants with questions during grading could correspond with the professor who had immediate online access to each paper. The other benefit was the time-stamping and logging of papers. In a class this large, questions traditionally arise about when a paper was submitted, just how late a late paper was, and even whether a student submitted or not. Our electronic log with time-stamps for each paper proved useful in several such cases when students came forward with problems. In one case, for instance, a student claimed to have submitted his paper late by just an hour or so, which would have fallen within our grace period; the log showed the paper a half-day late and immediately settled the matter.

The largest problem we encountered in this trial involved printing out physical copies of the papers for use in grading. On the principle of innovating just one step at a time, we chose not to require the ten Teaching Assistants in this class to grade papers electronically and return marked-up copies to students via e-mail or some other means. This meant we needed hard-copies of the papers. We also chose not to require students to submit both electronic and physical copies, because of the problems to which that might be susceptible: a student submitting versions that differed, a student submitting one on time but one late, a student submitting one but not the other, etc. Instead, we sorted, printed, and stapled the electronically submitted papers centrally using a high volume printer and then distributed these to each Teaching Assistant for grading.

Central printing produced several problems. We required students to submit in MS Word or WordPerfect format, but about thirty (5%) failed to do so and these papers required special attention. We also experienced loss of certain kinds of formatting, especially 'smart quotes' in some papers, apparently due to version differences in word processors.

About five students (<1%) encountered technical problems submitting their papers. We operated a live telephone hot-line for problems in the three hours before the paper was due, and handled a couple of problems after the due date without penalty to the students. These proved in all cases to be operator error at the student end: students attempting to submit twice, or in one case attempting to submit to us an entire directory of files from her computer.

7. Next Steps and Conclusions

We consider this trial a success and will continue to use Copyfind. We intend to extend the system within this large course in three ways. First, we will retain student papers over time and will compare future student submissions not only with one another but with the archive of past papers. Because the assignments in this class rotate every two or three years, the archive will never grow unwieldy in size.

Second, we aim to employ a standard Internet search engine such as Google to test for matches with our phrase lists from student papers. This will require some additional coding to submit the search strings and then read back and tabulate search results for each paper. While several uncertainties exist about the time needed for such searches and for the interpretation of results, the principles involved are straightforward. Open searching on the Internet will allow detection of plagiarism from a wide variety of sources, including in some cases even commercial term paper mills, because these often publicly post short excerpts from their stock of papers.

Third, we will move eventually to electronic grading of papers in order to eliminate the need for printing altogether. Having electronic copies of papers makes this possible, and the utilities for marking up text with highlighting, marginalia, and even audio notations are now widely available as part of most standard word processors. In this case, we will accept student papers electronically, copy each one, run one copy through our plagiarism detection routines while grading and marking up the other. We will then return the graded papers to students via e-mail.

We will also extend our experimentation within the campus by arranging trials in more courses within more departments. These trials, if successful at detecting and preventing plagiarism, will also help identify the nature and extent of services necessary to support the routine use of the system in whatever courses faculty members desire.

Because the core engine is freeware, the system certainly is usable at no direct cost to other institutions. The authors are glad to share their experience and suggestions with other potential users.

Our experience with this trial in plagiarism detection, and our deliberations about its purpose and future aims, leads us to the conclusion that university faculty bear some considerable responsibility for the current crisis in academic dishonesty. This crisis is more than simply a behavioral phenomenon in which an apparently growing fraction of students commit acts of misrepresentation and dishonesty. As a number of observers including Donald McCabe, founder of the Center for Academic Integrity at Duke University, have pointed out, the larger problem is the cavalier *attitude* toward cheating that seems to have grown among students. (Groark, Oblinger, Choa 2001) (Slobogin, 2002). The ease with which students can cheat undetected using new technology may have engendered the judgment that plagiarism is really not much of an ethical offense. Where rules are trivially easy to break and the makers of rules extend themselves little to detect violations, a strong if implicit signal is sent that the rules are not important. To the extent that universities have failed to respond adequately to cheating by maintaining a deterrent through detection, they bear some responsibility for the crisis. Fortunately a strong remedy is at hand. The first and fundamental step is to make the transition to electronic submission of student work. From this foundation, any of a number of possibilities, such as the one described here, are possible.

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