Plagiarism and Programming: A Survey of Student Attitudes

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ABSTRACT

This paper examines student attitudes towards a number of behaviors which range from acceptable means of seeking help on assignments to unacceptable behaviors such as copying from another student or paying someone to complete an assignment. Attitudes regarding such behaviors are compared based on the type of assignment (programming assignment, written essay, math problems). Findings indicate that students do perceive that there are differences in the acceptability of behaviors depending on assignment type. Further, the study examines the effect of an education campaign designed to increase student awareness as to which behaviors are permitted. Results suggest that faculty efforts to clarify expectations do result in a change in student attitudes regarding the acceptability of certain behaviors.

Keywords: Plagiarism, Programming, Student Attitudes

1. INTRODUCTION

Researchers have investigated academic dishonesty in college classes across a variety of disciplines, student classifications and geographical/cultural boundaries. For example, McCabe, Butterfield and Trevino (2006) investigated academic dishonesty in graduate business programs; Sheard, Dick, Markham, Macdonald and Walsh (2002) studied plagiarism among first year IT students; Grimes (2004) examined academic dishonesty among undergraduate business and economics students at eight universities in the United States, Central Asia and Eastern Europe.

In a review of the literature, Jian, Sandnes, Huang, Cai and Law (2008) identified a number of studies indicating that academic dishonesty is especially problematic in computer programming courses. The extent and severity of cheating in programming courses is reflected in a related body of literature focusing on the development and efficacy of methods for detecting plagiarized source code in programs submitted for a grade (Faidhi and Robinson, 1987; Chen, Francia, Li, McKinnon and Seker, 2004; Daly and Horgan, 2005; Moussiades and Vakali, 2005; Cosma and Joy, 2008; Frantzeskou, MacDonell, Stamatatos and Gritzalis, 2008; Ohno and Murao, 2009).

There has also been a considerable amount of work regarding academic dishonesty in the context of the Internet, where easy access to digital files makes plagiarism all but effortless to conduct. Researchers have investigated the premise that technology increases the opportunity and ease of student cheating (Lester and Diekhoff, 2002; Scanlon and Neumann, 2002; Ercegovac and Richardson, 2004; Ross, 2005; Etter, Cramer and Finn, 2006/2007; Stephens, Young and Calabrese, 2007; Molnar, Kletke and Chongwatpol, 2008), with empirical studies reporting somewhat mixed findings. Of particular interest to our work is the 2008 study by Molnar et al. which reported that "… students find it more acceptable to cheat when using IT than when not using IT" (p. 663). We extend the work of Molnar et al. (2008) by comparing student attitudes toward cheating behaviors when completing programming assignments (which by their very nature are IT-based) to those same attitudes when completing mathematics and essay assignments (which may or may not be IT-based).

This study has two major objectives. The first is to investigate whether college students apply the same standards of acceptability to cheating behaviors in programming assignments as they do to cheating behaviors in other assignments. To accomplish this goal, we conducted a survey to capture student perceptions of the acceptability of twelve behaviors when working on different types of individual graded assignments. These include computer programming, mathematics, and essay assignments. The behaviors included in the survey are based upon four categories of behavior previously identified by Sheard et al. (2002), Broeckelman-Post (2008) and Jian et al. (2008). These are: (1) seeking help from approved sources, (2) participating in unauthorized collaboration, (3) copying portions of others' work, and (4) copying all of others' work.

The second objective of the paper is to determine if faculty can influence the standards of acceptability that students apply to these behaviors through education about unethical behaviors, especially in the case of programming assignments. While some portion of cheating can certainly be attributed to students who engage in these behaviors despite knowing that they are wrong, some may also be due to students who do not fully understand which behaviors are and are not acceptable (Burrus, McGoldrick, and Schuhmann, 2007). Education efforts focused on clarifying the boundaries of acceptable behavior may help students to avoid inadvertent cheating.

The approach used in this study is a retrospective pre-test/post-test study in which students provide their view of the behaviors after class discussions on ethical and unethical behaviors related to academic dishonesty. A retrospective pre-test/post-test survey is typically administered after a learning event and asks respondents to give their perceptions both at the time the instrument is administered and before the learning event occurred. This approach has been successfully used in academic settings to evaluate the success of educational programs (Sheard et al., 2002; Drennan and Hyde, 2008; Moore and Tananis, 2009)

2. BACKGROUND AND LITERATURE REVIEW

Cheating and plagiarism by college students is an area of concern to academics both in their capacity as teachers and as researchers. Academic research in this area has a long tradition with some of the earliest works dating back to the early years of the 20th century (e.g., Barnes, 1904; Campbell, 1933; Drake, 1941). As might be expected, the body of literature on this topic is extensive and a full review is beyond the scope of the current paper. However, we present an overview of empirical research on cheating with special attention to the work most relevant to the current study. We divide this literature review into three broad areas. In the first area, we group those articles that explore the prevalence of cheating and the extent to which personal and environmental factors influence cheating. In the second area, we group articles assessing the impact of technology and the Internet on cheating. In the third, we group articles that focus on efforts to prevent, detect, and discourage cheating.

2.1 Cheating in general

Studies exploring the prevalence of cheating have found wide ranging results. The percentage of students who admit to some form of academic dishonesty ranges from a low of 3% (Karlins, Michaels and Podlogar, 1988) to a high of 95% (McCabe and Trevino, 1997). The disparities in cheating rates found in these studies can be attributed a variety of factors. They encompass different definitions of cheating and plagiarism, different methods of measurement, and different types of student work. For example, some researchers focused their investigations on homework or term papers (Youmans, 2011), some on exams (Genereux and McLeod, 1995), and some on a variety of student work (Diekhoff, LaBeff, Clark, Williams, Francis, and Haines, 1996). The wide spectrum of self-reported academic dishonesty rates may in part be due to the perception by many students that cheating on exams ('blatant' cheating) is different from other forms of academic cheating (less serious or 'not really' cheating) (Payne and Nantz, 1994). This distinction is important because the types of responses and interventions available to faculty vary greatly depending on the type of assignment (Passow, Mayhew, Finelli, Harding, and Carpenter, 2006).

The way in which cheating rates were determined may also be a factor in their wide variance. While much of the work in this area depends on self-reported measures to determine the rate of cheating (McCabe, Trevino and Butterfield, 2001), studies using measures of actual cheating behavior have also reported a broad range in rates of cheating. One of the early studies attempting to determine actual cheating behavior found the low 3% rate mentioned

previously (Karlins et al., 1988). At the other end of the spectrum, West, Ravenscroft and Schrader (2004) examined the relationship between actual cheating behavior and measures of moral judgment following a blatant incident in which 74% of a class cheated on a take-home exam. The advent of widely available text matching software tools such as Turnitin has increased the number of studies reporting rates of actual cheating behavior detected through use of the tools: these studies have reported rates ranging from 21% to 61% (Warn, 2006; Ledwith and Risquez, 2008; Martin, Rao and Sloan, 2009; Walker, 2010). Despite the attention given to academic dishonesty, the rate of occurrence does not appear to be declining and may be increasing (Haines, Diekhoff, LaBeff, and Clark, 1986; Park, 2003; Eastman, Iyer and Eastman, 2006).

Many of the studies on cheating have attempted to identify personal and environment factors associated with cheating. Crown and Spiller (1998) conducted an extensive literature review of the empirical literature on cheating in college courses and summarized findings on the influence of both personal and environmental factors on students' behavior. This review identified inconsistent findings across studies with respect to the impact of personal characteristics on students' propensity to cheat; factors such as gender, age/class, marital status and religious orientation did not show any consistent relationships with cheating. However, some factors were linked to cheating across multiple studies. For example, twelve of the fourteen studies examining student ability supported a relationship between lower student ability (measured by course grades, test scores, GPA, or ACT scores) and increased cheating. Likewise, three of four studies linked cheating with an external locus of control, three of four linked moral obligation with cheating, and two of three found that business majors were more likely to cheat than other majors. A number of studies completed after 1998 also showed inconsistent findings regarding the relationships between individual factors and the propensity to cheat (Allmon, Page and Roberts, 2000; Jackson, Levine, Furnham and Burr, 2002; Smith, Davy and Easterling, 2004; Teodorescu and Andrei, 2009; Walker, 2010).

Crown and Spiller's 1998 review also examined the effect of situational factors (including honor codes, sanctions, values counseling, surveillance, and peer context variables) on cheating. Two of the most commonly studied factors – surveillance and peer effects – showed the most consistent findings across studies. While one study found that cheaters are more willing to accept risk, nine out of nine studies found that surveillance (operationalized in various ways including the risk of being caught) was negatively related to cheating behavior. Similarly, six of six found that peer context variables such as observing others cheating, sitting next to a friend, and peer perceptions of and/or reactions to cheating were positively related to cheating behavior. In another study, McCabe and Trevino (1993) surveyed over 6,000 students at 31 academic institutions. This study, one of the largest studies examining the importance of contextual factors on students' perceptions of cheating behavior, found the perception of peer cheating behavior to have the strongest influence on cheating. Peer behavior outweighed other contextual factors which included the existence of an honor code, the certainty of being caught, understanding of the policy, and the severity of the penalty. Similar findings regarding the influence of peer behaviors were reported by Teodorescu and Andrei (2009) and Chapman, Davis, Toy and Wright (2004). Although, Chapman et al. (2004) also reported that the propensity to cheat decreased when the perceived risk and fear of being caught increased.

2.2 Cheating using IT

Technology has had a profound impact on the academic environment providing greater access to students in widespread locations and improving the ease of communicating and disseminating information (Mayfield and Ali, 1996). However, technology has also increased the opportunity and ease of student cheating. The extant literature contains numerous examples of students using technology to gain easy access to other's work or solicit unauthorized assistance. The most egregious forms of student cheating are the outright purchase of assignments such as term papers (Campbell, Swift and Denton, 2000) or completed assignments (Ross, 2005). Other common forms of digital cheating include copying and pasting unattributed material from online sources (Scanlon and Neumann, 2002; Stephens et al., 2007; Molnar et al., 2008).

Despite the recognition of how technology and the Internet have enabled increased cheating (Renard, 1999/2000; Ercegovac and Richardson, 2004), there has been relatively little academic literature offering empirical examinations of the phenomenon. Lester and Diekhoff (2002) conducted one of the earliest studies comparing characteristics of traditional cheaters and Internet cheaters. The study found that traditional cheaters tended to be women (65.2%) and Internet cheaters were more likely to be men (54.1%). Internet cheaters were also more likely to be involved with both varsity and intramural sports than traditional cheaters but no significant differences were found in other demographic factors. This study found that both traditional and Internet cheaters tended to justify their behaviors and that this justification was more prevalent in Internet cheaters. Finally, the study found that Internet cheaters were less likely to resent cheating behavior in others than were traditional cheaters.

Etter et al. (2006/2007) extended a list of specific cheating behaviors to include IT-related behaviors then examined the correlation of these behaviors with students' ethical principles and personality traits. Idealism (a sense that ethical behavior requires one to "do no harm" (Etter et al., 2006/2007, p. 136)), and disinhibition (a lack of constraint including disregard for social conventions) correlated significantly with academically dishonest behaviors. Although the authors incorporated IT-related cheating behaviors into the study they did not contrast those behaviors with more traditional means of cheating.

Stephens et al. (2007) surveyed 1,305 students from two universities on their use of digital and conventional methods for cheating, as well as their sense of moral responsibility to refrain from cheating and their tendency to justify cheating behavior. They found that most students who cheat use both conventional and digital methods to do so, with only 4.2% of the students in their sample reporting that they used digital methods exclusively. Students used conventional means

more often than digital means to copy homework, collaborate without authorization, and copy from others' exams, but preferred digital means for plagiarism and for unauthorized "cheat sheets" (i.e., notes stored in an electronic device such as a phone). Contrary to the authors' hypotheses, students did not view digital cheating as being less serious than conventional cheating. However, the authors concluded that a "student's beliefs about the seriousness of cheating is a strong negative predictor of cheating behavior, conventional and digital" and that "perceptions of peer acceptability of digital cheating were a strong positive predictor of digital cheating" (Stephens et al., 2007, p. 250).

Molnar et al. (2008) surveyed 708 undergraduate students across five different geographical academic locations regarding their perceptions of software/music/computer game piracy and the acceptability of using electronic and non-electronic means to (1) copy assignments and/or papers (in part or in whole), (2) buy or borrow a paper, and (3) illegally obtain answers to tests questions. Generally, students reported cheating when using IT to be more acceptable than cheating when not using IT. However, this finding differed when considered in the context of personal behavior as opposed to the behavior of others – students felt it was more acceptable to personally cheat when using IT than when not using IT, but this was not so for others. When IT was not involved the opposite attitude was observed – students found it was more acceptable for others to cheat than for themselves personally to cheat when not using IT. This suggests that students view cheating differently when IT is involved than when it is not. Additionally, when IT is involved, students may justify personally cheating but not justify the cheating of others.

2.3 Faculty Influence on Cheating

Several of the studies mentioned above offer implications for how faculty may influence student beliefs about cheating. Specifically, Stephens et al. (2007) suggest that strategies focused on preventing cheating (i.e., educating students about these issues) may be more effective than those that focus on catching students after the fact. They also suggest that creative assignments, particularly those that guide students through the process of reducing a large project into a series of manageable tasks, as well as creating a culture that promotes values such as honesty and responsibility are good strategies for preventing cheating. Simkin and McLeod (2010) found that one reason students choose not to cheat is the presence of a "moral anchor" such as a faculty member with strong ethical standards. Molnar et al. (2008) suggest that including coverage of IT ethics in university curricula may bring about positive changes in student attitudes and behaviors regarding the ethical use of IT. Similarly, Allmon et al. (2000) advocate the need for ethical training as it relates to the use of information technology.

Additional studies have explored ways in which faculty can influence cheating behaviors. For example, Brown and Howell (2001) assessed the effect of policy statements on students' perceptions of the seriousness of plagiarism. They found that an educational policy statement informing students about appropriate citation procedures was more effective at raising awareness than a warning statement identifying the penalties for plagiarism. Burrus et al. (2007) surveyed students about cheating behavior before and after providing specific definitions of cheating. They found that reports of cheating increased after providing the definition suggesting that students often fail to understand what constitutes cheating. These authors suggest that "an obvious first step toward combating cheating would be to provide clear and consistent reminders of which behaviors are unacceptable" (Burrus et al., 2007, p. 14). Broeckelman-Post (2008) investigated whether faculty-led discussions about academic dishonesty can affect student behavior. Broeckelman-Post surveyed graduate students, undergraduate students and faculty at one university regarding two different levels of plagiarism and several types of collaboration. Although faculty who discussed academic dishonesty with their students and/or employed measures to prevent academic dishonesty were more likely to observe academically dishonest behavior, incorporating measures to prevent academic dishonesty and talking about academic dishonesty was nonetheless found to be worthwhile. The results also indicated that conveying assignment-specific expectations for behavior is more effective than general discussions of academic dishonesty. Ultimately, however, students in this study were more strongly influenced by their perceptions of peers' behaviors than by classroom discussions. Based upon this finding, Broeckelman-Post suggested that creating an environment where it is perceived that others are not cheating is important, which in turn, further underscores the importance of faculty imposed deterrents to and intolerance for cheating.

Approaching the topic from a slightly different angle, Franklyn-Stokes and Newstead (2010) investigated the reasons for not cheating as part of a larger study on undergraduate cheating in the United Kingdom. Interestingly, they found that the fear of being caught or punished was not one of the main reasons for not cheating. Instead, the most commonly reported reasons given for not cheating were that it was unnecessary and would have been dishonest. Once again, the authors concluded that students need to be educated about what constitutes cheating and that it is "wiser to concentrate on informing students as to what behavior is deemed acceptable, rather than introducing draconian sanctions" (Franklyn-Stokes and Newstead, 1995, p. 170)

3. HYPOTHESES

As previously noted, a number of researchers have commented on the prevalence of cheating with respect to programming assignments and other computer based work (Joy and Luck, 1999; Ross, 2005; Buchanan, 2006; Cosma and Joy, 2008; Jian et al., 2008). However, very few researchers have compared cheating on programming assignments to cheating on traditional assignments; furthermore, the findings from the few studies that have looked at this issue in the broader context of IT based assignments versus non-IT based assignments are not consistent. Molnar et al (2008) found that undergraduate students rated cheating with IT as more acceptable than cheating without the use of IT. Stephens et al. (2007), on the other hand, found that students did not express different

perceptions about the seriousness of cheating in a digital context versus a standard context. Given that there is limited and contradictory guidance from the literature, we must consider other possible arguments.

In the current study, we extend the work of Molnar et al. (2008) by comparing student perceptions of cheating on different types of assignments – programming assignments, essay assignments, and math assignments. These assignment types share some common characteristics but also have distinguishing features. Programs and essays are typically written on a computer; math assignments may be done on a computer or by hand. It could be argued that the prevalence of cheating on programming assignments is at least in part due to the fact that the electronic file produced for such an assignment is very easy to copy. If ease of copying is the primary driver of academic dishonesty in IT-based assignments, then in all likelihood we would not see a difference in student perceptions between programming assignments and essays because most essays are also created as electronic files. However, we may see a difference between these two assignment types and math assignments, depending on the extent to which math assignments are completed by hand.

Math assignments may also be distinguished by the mental linkages that students make between assignment completion and exam performance. In other words, students may not see any value in cheating on math assignments as they may fear they will not be able to perform on the exam if they do not complete the homework assignments. By the time a student is in college, they have completed multiple math courses and have learned that individual exam performance is related to the amount of "practice" an individual has done with homework assignments. However, many students have little or no experience taking programming courses, and may not have made the same connection between exam performance and programming assignments.

Another difference between assignment types has to do with the amount of variation we would expect to see in the submitted work and the impact of that variation on students' perceptions. Essay assignments typically allow students to present their own point of view on a topic and give them room for creative expression. The end product of an essay assignment may vary dramatically across a group of students as they each explore their own interpretations of the topic. However, depending on their complexity, programming and math assignments typically offer students less room for individual variation and show greater similarity in the end results – the solution to a math problem is either correct or incorrect, a computer program either works or it does not. Relatively simple programming assignments based on a limited number of concepts and techniques are likely to result in very similar submissions while more complex assignments that integrate across a wider range of concepts and techniques are likely to produce greater variation in the submitted assignments.

We believe there are two ways in which the similarity of assignments might impact students' perceptions. First, is the fear of being caught cheating. Students who are working on essay assignments might hesitate to copy from classmates if they anticipate that their professor would notice excessive similarity. Online plagiarism detection resources such as Turnitin may also deter students from submitting essays that include work copied from Internet sources (Martin et al., 2009). However, when students expect that the work they submit will by its very nature be highly similar to that of other students, the fear of getting caught may no longer be a strong deterrent. Additionally, students may use this expected similarity as a rationale for neutralizing (or justifying) the lapse in moral responsibility associated with cheating. According to Stephens et al.(2007), neutralization techniques include "minimizing consequences ("it's no big deal"), euphemistic labeling ("it's not really cheating"), displacing responsibility ("it's my teachers' fault"), and diffusing responsibility ("everyone else was doing it")" (Stephens et al., 2007, p. 235). Similarly, students may use perceptions of a lack of creative investment in programming assignments to justify the acceptability of otherwise immoral actions. Based upon these arguments, the following hypotheses are proposed:

H1: Students have different perceptions as to what constitutes academically dishonest behavior for programming assignments than math assignments.

H2: Students have different perceptions as to what constitutes academically dishonest behavior for programming assignments than essay assignments.

Additionally, we believe that educating students as to what constitutes academically dishonest behavior on programming assignments can alter student perceptions. Such educational campaigns have been advocated by a number of researchers including Franklyn-Stokes and Newstead (2010), Allmon et al. (2000), McCabe et al. (2001), Trevino, Stephens et al. (2007), Broeckelman-Post (2008), and Jian et al. (2008). Empirically, based on a preliminary analysis of the data, Molnar et al. found that "… students who have had some coverage of ethics in an IS-related class showed stronger support of the IT-related ethical behaviors than students who have not had coverage of ethics in an IS-related class" (Molnar et al., 2008, p. 668). Accordingly, we also hypothesize the following:

H3: Education on behaviors related to academic dishonesty on graded programming assignments will change student perceptions as to what constitutes academically dishonest behavior on programming assignments.

H4: Education on behaviors related to academic dishonesty on graded programming assignments will change student perceptions as to what constitutes academically dishonest behavior on essay assignments.

H5: Education on behaviors related to academic dishonesty on graded programming assignments will change student perceptions as to what constitutes academically dishonest behavior on math assignments.

4. METHODOLOGY

The primary purpose of this study is to understand if and how academic dishonesty is viewed differently for programming assignments as compared to more traditional math and essay assignments. The secondary purpose is to determine if education about academic dishonesty policies can change student perceptions, specifically in the case of programming assignments. To this end, a survey was designed and administered to students. After examining current literature on categories of academic behavior related to graded class assignments (Sheard et al., 2002; Broeckelman-Post, 2008; Jian et al., 2008), we developed three sets of twelve questions – one set each for programming, mathematical and essay assignments (see Appendix – Survey Instrument). The mapping of the categories from the literature to the questions in the survey is provided in Table 1.

Categories of Academic Behavior	Survey Questions
Seeking help from approved sources	1 - 3
Unauthorized collaboration	4 - 6
Copying portions of others' work	7 - 9
Copying all of others' work	10 - 12

Table 1: Mapping of categories of academic behavior from literature to survey questions

The survey was administered to undergraduate students in four different undergraduate programming courses at a university in southern Georgia (see Table 2 for a list of those courses). The survey asked respondents to indicate (on an interval assumed 5-point Likert scale where *1=Very Acceptable Behavior* and *5=Very Unacceptable Behavior*) how acceptable they felt the specified behaviors were when working on an assignment that is to be completed individually for a grade. We included several demographic questions to gather information about the respondents. The survey was anonymous in that it included no identifying information that could tie an individual student back to her/her response.

An additional goal of this research was to determine whether education could influence student perceptions regarding certain behaviors on programming assignments. This education was delivered by the instructor of record in several forms throughout the semester. Each of the instructors included a statement in the course syllabus. This policy statement was accompanied by an extensive classroom discussion at the beginning of the semester. The instructors also included policy statements on programming assignments and discussed these policies in class. An example of these statements is shown below:

"All code that you submit for a grade must be your original work. This is an individual assignment; you are not permitted to work with another student, copy any portion of another student's work, or share your work with another student."

Verbal reminders of the policy were also delivered at numerous times during the semester both in the classroom setting and, when relevant, to individual students. Students were encouraged to seek assistance from their instructor or from the official course tutor.

The survey was administered by a third party (not the instructor of record) as a retrospective pre-test/post-test instrument given at the end of the semester. A retrospective pre-test/post-test survey is administered after an educational event and asks respondents to consider their responses both before and after the event occurred on a single survey instrument. This approach was chosen for two reasons. First, we were concerned that student responses might be biased if we were to ask them to provide their names or other identifying information in order to match pretest and posttest measures administered at different times. Using the retrospective design allowed us to administer the surveys in a completely anonymous fashion thus preserving students' privacy. Second, this approach has been successfully used in educational settings to offset the possibility of response shift bias. A response shift may occur when an intervention, such as our academic dishonesty education, is delivered with the goal of encouraging respondents to reconsider beliefs or attitudes on a subject (Sprangers and Hoogstraten, 1989). Such education may have the effect of changing the respondents' internal scale or metric against which they evaluate their responses to self-report survey items (Moore and Tananis, 2009). Such a response shift would compromise the internal validity of a traditional pre-test/post-test design. The survey was administered to 155 respondents. All but five responses were complete enough to use for analysis (n=150).

5. DATA ANALYSIS

5.1 Demographics of Respondents

Respondents were mostly from three computing majors that require one or more of the four programming courses: information technology (46.7%), information systems (18.7%) and computer sciences (14.0%). The remaining 20.6% of respondents represented a variety of other majors from across campus. The majority of respondents (68%) were male, with females accounting for 26% of the sample. The remaining 6% did not identify their gender. Ninety-two percent (92%) of the respondents were age 24 or younger. Nearly half (47.3%) of the respondents identified themselves as having a GPA of 3.0 or above. The breakdown of respondents by the course in which they were enrolled is presented in Table 2.

5.2 Confirmatory Factor Analysis

We conducted a confirmatory factor analysis (CFA) to identify the underlying structure of the data, confirm the categories proposed in Table 1, and reduce the number of variables in the analysis (Hair, Anderson, Tatham, and Black, 1998). Based on the initial fit of the CFA model, question 9 (making minor changes to an assignment submitted for a previous course and submitting it for the current course) was removed and question 6 (working together and submitting similar work) was moved from the category of unauthorized collaboration to copying part of an assignment. The rationale for removing question 9 was that it did not apply to the courses taught as they are primarily introductory in nature and cover a spectrum of different

topics. Therefore, it is unlikely that students would have a body of similar previous work available. The rationale for moving question 6 was a matter of fit. The statistics measuring fit for the CFA model improved when question 6 was moved from unauthorized collaboration to copying part of an assignment. As the question can logically go in either category, the authors decided to include it in the copying part of an assignment category.

Course	Description	Number of Respondents (%)
CSCI 1236 Introduction to Java Programming	A first course in the Java programming language targeted to Information Technology (IT) and Information Systems (IS) majors. Students are mostly freshmen.	43 (28.67%)
CSCI 1301 Programming Principles I	A first course in the Java programming language targeted to Computer Science (CS) majors. Students should have taken a programming class such as *Introduction to Basic Programming* before taking this class. Students are mostly freshmen.	13 (8.67%)
IT 1430 Web Page Development	A course in XHTML, CSS and JavaScript for IT students as well as several other majors across campus that require the course for their program. IT students are typically freshmen, while the other majors are usually seniors.	38 (25.33%)
CISM 2230 Advanced Java	A second course in the Java programming language that is almost exclusively IT and IS majors at the sophomore level.	56 (37.33%)

Table 2: Courses where students were surveyed

The final four factor solution from the CFA is provided in Table 3. A summary of the statistics related to overall fit of the final model is provided in Table 4. The level of significance is greater than the recommended 0.05 for programming assignments, chi-square divided by the degrees of freedom (chi-square/DF) is less than the recommended 3 in all cases, the normed fit index (NFI) is greater than the recommended 0.90 in all cases, the Tucker-Lewis index (TLI) is greater than the recommended 0.90 in all cases, the comparative fit index (CFI) is greater than the recommended 0.90 in all cases, the root mean square error of approximation (RMSEA) is less than the recommended 0.80 indicating a close or reasonable fit for all but the math assignments and the standardized root mean squared residual is less than the recommended 0.10 for all but the math assignments (Kline, 2005). Overall, based on the combined statistics, the model has an acceptable to good fit for all six sets of data for the four factors identified in Table 3. Finally, reliability of each measure was assessed using Cronbach's alpha and the values are provided in Table 5. In all cases, Cronbach's alpha is below the recommended level of 0.70 (Hair et al., 1998).

Category	Survey Questions Corresponding to CFA
Authorized Help	1 - 3
Unauthorized Discussion	4 - 5
Copying Part of an Assignment	6 - 8
Copying All of an Assignment	10 - 12

Table 3: Final four factor solution from confirmatory factor analysis

5.3 Hypothesis Testing

The first set of hypotheses concern students' perceptions of academic dishonesty on three different types of assignments:

H1: Students have different perceptions as to what constitutes academically dishonest behavior for programming assignments than math assignments.

H2: Students have different perceptions as to what constitutes academically dishonest behavior for programming assignments than essay assignments.

To determine whether students have different perceptions about what constitutes academically dishonest behavior for different types of assignments, we compared their perceptions for each category of behavior across the different assignment types. More specifically, perceptions regarding programming assignments are compared to those for math and essay assignments. Table 6 shows the results for hypothesis H1 using matched pair t-tests to compare perceptions of programming assignments to those of math assignments. Table 7 shows the results for hypothesis H2 using matched pair t-tests to compare perceptions of programming assignments to those of essay assignments. Tables 6 and 7 represent student perceptions at the beginning of the semester and thus are pre-test results.

The only significant difference in perceptions for programming assignments versus math assignments is in copying part of the assignment (see Table 6). Students perceive copying part of a programming assignment as more unacceptable than copying part of a math assignment.

As shown in Table 7, perceptions related to seeking authorized help, engaging in unauthorized discussion and copying part of an assignment differ for essay assignments as compared to programming assignments. Specifically, seeking authorized help for a programming assignment is more acceptable than for an essay; having unauthorized discussions is more acceptable for a programming assignment than for an essay; and copying part of a

programming assignment is more acceptable than for an essay. The pre-test finding that students perceive that copying part of a programming assignment and engaging in unauthorized discussions is more acceptable than similar behaviors for an essay assignment is problematic

	Programming Before	**Programming Now**	**Essay Before**	**Essay Now**	**Math Before**	**Math Now**
Chi-square	47.603	38.674	68.846	61.077	96.373	79.115
Significance	0.137*	0.439*	0.002	0.01	< 0.000	< 0.001
Chi-square/DF	1.253*	1.018*	1.812*	1.607*	2.536*	2.082*
NFI	0.959*	0.963*	0.934*	0.947*	0.925*	0.927*
TLI	0.987*	0.999*	0.955*	0.97*	0.931*	0.942*
CFI	0.991*	0.999*	0.969*	0.979*	0.952*	0.96*
RMSEA	0.041*	0.011*	0.074**	0.064**	0.102***	0.085***
SRMR	0.0481*	0.0454*	0.0618*	0.059*	0.793***	0.745***
Fit Assessment	**Good**	**Good**	**Acceptable**	**Acceptable**	**Acceptable**	**Acceptable**
*a good fit, **a reasonable fit, ***a poor fit according to statistic						

Table 4: Fit statistics for final four factor solution from CFA

Factor	**Programming Before**	**Programming Now**	**Essay Before**	**Essay Now**	**Math Before**	**Math Now**
Authorized Help	0.884	0.868	0.836	0.832	0.878	0.846
Unauthorized Discussion	0.826	0.833	0.747	0.751	0.875	0.824
Copy Part	0.859	0.873	0.787	0.824	0.871	0.865
Copy All	0.920	0.906	0.936	0.954	0.927	0.889

Table 5: Cronbach's alpha for final four factor solution from CFA

Category	**Questions**	**Difference in means**	**Standard Deviation**	**t-test statistic**	**p-value**
Authorized help	1, 2, 3	0.02908	0.52122	0.681	0.497
Unauthorized discussion	4, 5	0.05369	0.83654	0.783	0.435
Copy part	6, 7, 8	0.13199	0.77578	2.077	**0.040
Copy all	10, 11, 12	0.01333	0.62137	0.263	0.793
***significant at 1%, **significant at 5%, *significant at 10%					

Table 6: Pre-test results of paired t-tests for hypothesis H1 (programming assignments compared to math assignments) for each of the four categories

Category	**Questions**	**Difference in means**	**Standard Deviation**	**t-test statistic**	**p-value**
Authorized help	1, 2, 3	-0.40959	0.70865	-7.149	***0.000
Unauthorized discussion	4, 5	-0.26316	0.81774	-3.968	***0.000
Copy part	6, 7, 8	-0.50658	0.84916	-7.355	***0.000
Copy all	10, 11, 12	-0.05298	0.54173	-1.202	0.231
***significant at 1%, **significant at 5%, *significant at 10%					

Table 7: Pre-test results of paired t-tests for hypothesis H2 (programming assignments compared to essay assignments) for each of the four categories

The next logical questions would be (1) can we alter these perceptions through education about what constitutes cheating as it specifically relates to programming assignments, and (2) will such an education also alter perceptions of what constitutes cheating on graded essay and math assignments.

H3: Education on behaviors related to academic dishonesty on graded programming assignments will change student perceptions as to what constitutes academically dishonest behavior on programming assignments.

H4: Education on behaviors related to academic dishonesty on graded programming assignments will change student perceptions as to what constitutes academically dishonest behavior on essay assignments.

H5: Education on behaviors related to academic dishonesty on graded programming assignments will change student perceptions as to what constitutes academically dishonest behavior on math assignments.

To determine whether education made a difference on student perceptions on each type of assignment, matched pair t-tests were used to compare perceptions prior to education on academic dishonesty to perceptions after class discussions about academic dishonesty. As the survey design was based on a retrospective pre-test/post-test design, there was no need to use markers to match responses as all responses for a single individual were recorded on a single survey. Results of t-tests for hypotheses H3 (programming assignments), H4 (essay assignments) and H5 (math assignments) are presented in Tables 8, 9 and 10, respectively.

Category	Questions	Difference in means	Standard Deviation	t-test statistic	p-value
Authorized help	1, 2, 3	0.07407	0.50758	1.805	*0.073
Unauthorized discussion	4, 5	-0.01299	0.58003	-0.278	0.781
Copy part	6, 7, 8	-0.26316	0.51559	-6.293	***0.000
Copy all	10, 11, 12	-0.06536	0.30121	-2.684	***0.008
***significant at 1%, **significant at 5%, *significant at 10%					

Table 8: Paired t-tests for hypothesis H3 comparing before education to after education for programming assignments for each of the four factors

Category	Questions	Difference in Means	Standard Deviation	t-test statistic	p-value
Authorized help	1, 2, 3	0.10968	0.54004	2.528	**0.012
Unauthorized discussion	4, 5	0.02632	0.58341	0.556	0.579
Copy part	6, 7, 8	-0.05411	0.36648	-1.832	*0.069
Copy all	10, 11, 12	-0.02832	0.23554	-1.487	0.139
***significant at 1%, **significant at 5%, *significant at 10%					

Table 9: Paired t-tests for hypothesis H4 comparing before education to after education for essay assignments for each of the four factors

Category	Questions	Difference in Means	Standard Deviation	t-test statistic	p-value
Authorized help	1, 2, 3	0.06181	0.28128	2.700	***0.008
Unauthorized discussion	4, 5	-0.01667	0.35905	-0.569	0.571
Copy part	6, 7, 8	-0.10515	0.39152	-3.278	***0.001
Copy all	10, 11, 12	-0.04444	0.31056	-1.753	*0.082
***significant at 1%, **significant at 5%, *significant at 10%					

Table 10: Paired t-tests for hypothesis H5 comparing before education to after education for math assignments for each of the four factors

One positive finding is that students perceive copying part of a programming assignment and copying all of it to be more unacceptable (t-statistic negative) after discussions about academic dishonesty than prior to such discussions – an indication that education does make a difference in perceptions (see Table 8). In addition, students view seeking authorized help for programming assignments as somewhat more acceptable after education (t-statistic positive). This is also good in that education helps students understand that they can get assistance with programming assignments; it also helps them to recognize authorized sources for such assistance. However, the finding that there is no difference in perceptions about engaging in unauthorized discussions relating to programming assignments before and after education is problematic and merits further investigation. We note that when the t-test was performed using the absolute value of differences, the p-value was less than .01 which means there is a difference, but the direction is mixed so that the difference is sometimes positive (more acceptable) and sometimes negative (less acceptable). That is, some students perceived participation in unauthorized discussions as more acceptable after education, others perceived it as less acceptable, and some had no change in perception.

The education campaign in the programming course produced some slight differences in perceptions for graded essay assignments (see Table 9). As stated previously, students receive a good deal of education about plagiarism on writing assignments, so this result was expected. Students perceived copying part of an essay assignment as more unacceptable at the end of the course than at the beginning indicating that education made a difference. Students also perceived seeking authorized help on an essay assignment as more acceptable after education. This further supports the notion that education helps students understand that they can get assistance with assignments and also helps them recognize authorized sources of such assistance. As with programming assignments, there is no difference in perceptions about participating in unauthorized discussions for essay assignments and, once again, there is a change in perception at the individual student level but the change is mixed in that some students see unauthorized discussion as more acceptable and others as less acceptable. The changes in perceptions for graded math assignments (see Table 10) are similar to those seen for programming as students see copying part of an assignment or copying all of it as more unacceptable and seeking authorized help as more acceptable. There is no difference in perceptions about participating in unauthorized discussion.

6. DISCUSSION

In an article in *NetworkWorld*, Marsan (2010) reported that 50% of the academic dishonesty cases at the University of Washington and 23% of cases at Stanford involved computer science students – with the majority of violations coming from introductory programming courses. One of the reasons for cheating on programming assignments cited by Marsan (2010) is that students think that solutions to programming problems are similar to mathematical proofs; they do not realize that different approaches to the same problem can generate correct output, leading them to believe that if a friend found the "right" answer (and there can only be one) then they cannot be caught if they cheat. Additionally, they fail to recognize that like writing an essay, designing and writing code also involves creativity.

Whether their perceptions are correct or not, the article by Marsan (2010) suggests that students see similarities between programming assignments and math assignments, and differences between programming assignments and essay assignments. Similarly, our study suggests that, for the most part, student perceptions about behaviors related to programming assignments were much more in line with those of math assignments than those related to essay assignments. Specifically, we found that students perceive that: (1) seeking authorized help on programming assignments is more acceptable than seeking authorized help on essay assignments; (2) copying part of a programming assignment is more acceptable than copying part of an essay assignment, but less acceptable than copying part of a math assignment; and (3) participating in unauthorized discussions about a programming assignment is more acceptable than doing so for an essay assignment.

Based upon the results of our survey, one way to address the issue is for faculty to hold classroom discussions about academic dishonesty as it relates to programming assignments. After the educational campaign, students viewed seeking authorized help on all three types of assignments as more acceptable. After education, students also thought that copying part of any type of assignment and copying all of a programming or math assignment was more unacceptable after education. The next logical step is to determine if education not only makes a difference in perceptions, but whether it makes a difference in actual behavior.

In our study, the educational campaign failed to change perceptions related to unauthorized discussions for all three assignment types in any meaningful way. For some students, participating in unauthorized discussions was perceived as more acceptable after education while for others the opposite was true. This suggests that faculty need to do more to help students understand where the line is. One approach would be to use situational examples such as those employed by Chapman et al. (2004) to provide examples of what is acceptable and what is not. Additionally, more should be done to emphasize that such discussions are unlikely to improve test performance if concepts are not understood and techniques not practiced.

Another option is to adopt standards that allow for collaboration on programming assignments. For example, at Georgia Tech such collaboration is viewed as an important learning method. Under the Georgia Tech model, students must sign a document outlining the forms of collaboration that are and are not allowed. For each assignment students must disclose the names of all collaborators and cite any websites or other materials used to complete the assignment. Students are required to demonstrate that they understand how the code works by giving individual oral presentations to one of the teaching assistants, and a higher percentage of the course grade comes from the tests and a lower percentage comes from the homework (Marsan, 2010). According to Marsan (2010) the attitude at Georgia Tech is that computing is best learned in a group and as long as students learn from

each other, collaboration within the specified limits (http://www.cc.gatech.edu/~agray/6240spr11/WhatIsAllowed.pdf) is not only acceptable but encouraged.

7. LIMITATIONS AND FUTURE RESEARCH

One limitation of this study arises from the potential bias of surveying students in our own classes. Even though a third party physically administered the survey instruments, we cannot rule out the possibility that our students told us what they thought we wanted to hear or were concerned about how their answers (although anonymous) might impact their grades.

Our study is also limited by the fact that our survey captured student perceptions. Future research investigating whether changes in perceptions about academic dishonesty translate to changes in actual behavior is essential.

We chose to use a retrospective pre-test/post-test design to capture student perceptions in this study with the goal of preserving students' anonymity and minimizing the potential of response shift bias. However, it would be interesting to compare the results from this study with those obtained from a traditional pre-test/post-test design. Future research may wish to make such a comparison.

Other limitations have to do with our sample. The first of these is that all of the survey respondents attend the same university. A second is that although we examined courses offered in three different computing disciplines, all of the respondents were enrolled in introductory level programming courses. A third is that our sample size (n=150) was relatively small. Future studies should draw from a larger sample and include students enrolled at a broader cross-section of universities and course levels. Additionally, in keeping with the extant literature, potential differences based upon gender, age/class, major and other demographic characteristics could be explored.

Another interesting avenue for future research stems from our finding that education failed to alter perceptions about unauthorized discussions. A first step is to determine why students feel the way they do about unauthorized discussions. A qualitative investigation of students' perceptions, such as the study conducted by Power (2009), would provide valuable insights upon which further studies designed to bring about changes in those perceptions could be based.

Additionally, it would be insightful to explore collaboration models such as the one adopted at Georgia Tech to examine if and how such an approach influences student perceptions, behaviors and performance in programming courses. Cooperative learning and pair programming are effective pedagogical tools that have been shown to enhance student learning and satisfaction (Johnson, Johnson and Smith, 2007; Salleh, Mendes and Grundy, 2011). Further, industry development such as agile methods and eXtreme programming are heavily dependent on a collaborative work style (Mishra and Mishra, 2009). In addition to improving student performance in the classroom, a collaborative approach may also help to better prepare students for a team oriented environment they will face in the workplace.

8. CONCLUSION

In many ways, researchers attempting to understand and influence student perceptions and behaviors related to cheating are fighting an uphill battle. As noted by Park (2003), "…many students generally regard plagiarism as 'no big deal'" (p. 476). Many students view cheating on exams ('blatant' cheating) as different from other forms of academic cheating (less serious or 'not really' cheating.) (Payne and Nantz, 1994). "In the overall scheme of things, students often view plagiarism as a relatively minor offence," (Park, 2003, p. 476). Similar reports abound in the popular press. For example, Gabriel (2010) reported that copying from the web is considered "serious cheating" by only 29% of those recently surveyed (as compared to 34% earlier this decade) and suggested that the Internet and digital technologies may be "redefining how students… understand the concept of authorship and the singularity of any text or image" (p. A1). However, Gabriel (2010) also provided alternative viewpoints advocating the enforcement of traditional academic standards.

This study has examined students' perceptions of plagiarism and other forms of academic dishonesty as they pertain to programming assignments. While many universities require students to complete first year orientation and/or writing courses that teach them why and how to document sources of information, it seems that students are missing the point when it comes to the writing of source code. Given that today's students have grown up in a world where digital technologies are ubiquitous, we should expect them to turn to such technologies when completing assignments (Gabriel, 2010). As this study did find that education about what constitutes academic dishonest behavior for graded programming assignments does make a difference in student perceptions, educators need to be diligent about clearly outlining what is acceptable and what is not acceptable as well as constantly reminding students about course policies as they relate to academic dishonesty. This is in line with the findings of Simkin and McLeod (2010) that the presence of an ethical faculty member with opinions that students respected was one reason students chose not to cheat. The next step is to see if education can make a difference in behavior as well. Clearly, much work remains to be done to affect changes in perceptions and behaviors related to programming and plagiarism.

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APPENDIX 1 – SURVEY INSTRUMENT

Please consider each of the following scenarios regarding class assignments and rate the degree to which you consider the listed behaviors to be acceptable before you took this course versus now.

You are working on a graded essay assignment for a class; your professor has told you this is an individual assignment. How acceptable are the following behaviors?	**Before taking this course**					**Now**				
	Very Acceptable				Very Unacceptable	Very Acceptable				Very Unacceptable
1. Asking the professor for help on the essay.	1	2	3	4	5	1	2	3	4	5
2. Asking a university provided tutor for help on the essay.	1	2	3	4	5	1	2	3	4	5
3. Reviewing similar essays in your textbook for ideas on how to write your essay.	1	2	3	4	5	1	2	3	4	5
4. Discussing ideas about the essay with a fellow student but writing the essays independently of each other.	1	2	3	4	5	1	2	3	4	5
5. Discussing ideas about the essay on an Internet news group, social networking site or blog.	1	2	3	4	5	1	2	3	4	5
6. Working together on the essay with a fellow student and submitting similar essays.	1	2	3	4	5	1	2	3	4	5
7. Copying a few sentences of another student's essay while adding a significant portion of your own work.	1	2	3	4	5	1	2	3	4	5
8. Copying a few sentences from the Internet or a written source while adding a significant portion of your own work.	1	2	3	4	5	1	2	3	4	5
9. Making minor changes to an essay you had previously written for another class and submitting it for this class.	1	2	3	4	5	1	2	3	4	5
10. Posting the assignment on an Internet news group, social networking site or blog asking someone to write the essay for you.	1	2	3	4	5	1	2	3	4	5
11. Hiring someone or asking a tutor to write the essay for you.	1	2	3	4	5	1	2	3	4	5
12. Copying another student's essay, making minor changes, and submitting it as your own work.	1	2	3	4	5	1	2	3	4	5

You are working on a graded programming assignment for a class; your professor has told you this is an individual assignment. How acceptable are the following behaviors?	**Before taking this course**					**Now**				
	Very Acceptable				Very Unacceptable	Very Acceptable				Very Unacceptable
1. Asking the professor for help on the program.	1	2	3	4	5	1	2	3	4	5
2. Asking a university provided tutor for help on the program.	1	2	3	4	5	1	2	3	4	5
3. Reviewing similar programs in your textbook for ideas on how to write your program.	1	2	3	4	5	1	2	3	4	5
4. Discussing ideas about the program with a fellow student but implementing the ideas independently.	1	2	3	4	5	1	2	3	4	5
5. Discussing ideas about the program on an Internet news group, social networking site or blog.	1	2	3	4	5	1	2	3	4	5
6. Working together on the program with a fellow student and submitting similar programs.	1	2	3	4	5	1	2	3	4	5
7. Copying a few lines of another student's program while adding a significant portion of your own work.	1	2	3	4	5	1	2	3	4	5
8. Copying a few lines of the program from the Internet or a textbook while adding a significant portion of your own work.	1	2	3	4	5	1	2	3	4	5
9. Making minor changes to a program you had previously written for another class and submitting it for this class.	1	2	3	4	5	1	2	3	4	5
10. Posting the assignment on an Internet news group, social networking site or blog asking someone to write the program for you.	1	2	3	4	5	1	2	3	4	5
11. Hiring someone or asking a tutor to write the program for you.	1	2	3	4	5	1	2	3	4	5
12. Copying another student's program, making minor changes, and submitting it as your own.	1	2	3	4	5	1	2	3	4	5

You are working on a graded math assignment for a class; your professor has told you this is an individual assignment. How acceptable are the following behaviors?	**Before taking this course**					**Now**				
	Very Acceptable				Very Unacceptable	Very Acceptable				Very Unacceptable
1. Asking the professor for help on the assignment.	1	2	3	4	5	1	2	3	4	5
2. Asking a university provided tutor for help on the assignment.	1	2	3	4	5	1	2	3	4	5
3. Reviewing similar problems in your textbook for ideas on how to complete your assignment.	1	2	3	4	5	1	2	3	4	5
4. Discussing ideas about the assignment with a fellow student but implementing the ideas independently.	1	2	3	4	5	1	2	3	4	5
5. Discussing ideas about the assignment on an Internet news group, social networking site or blog.	1	2	3	4	5	1	2	3	4	5
6. Working together on the assignment with a fellow student and submitting similar work.	1	2	3	4	5	1	2	3	4	5
7. Copying a small part of another student's assignment while adding a significant portion of your own work.	1	2	3	4	5	1	2	3	4	5
8. Copying a small part of the assignment from the Internet or a written source while adding a significant portion of your own work.	1	2	3	4	5	1	2	3	4	5
9. Making minor changes to an assignment you had previously completed for another class and submitting it for this class.	1	2	3	4	5	1	2	3	4	5
10. Posting the assignment on an Internet news group, social networking site or blog asking someone to complete the work for you.	1	2	3	4	5	1	2	3	4	5
11. Hiring someone or asking a tutor to complete the assignment for you.	1	2	3	4	5	1	2	3	4	5
12. Copying another student's work, making minor changes, and submitting it as your own.	1	2	3	4	5	1	2	3	4	5

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