


First-year university science and engineering students' understanding of plagiarism

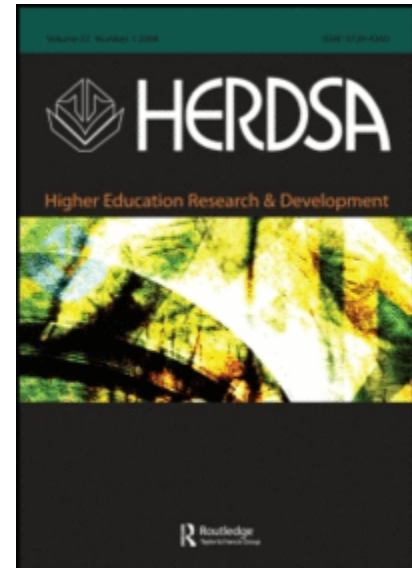
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Abstract

This paper is a case study of first-year science and engineering students' understandings of plagiarism. Students were surveyed for their views on scenarios illustrating instances of plagiarism in the context of the academic work and assessment of science and engineering students. The aim was to explore their understandings of plagiarism and their judgement about the seriousness of each incident, and to shed light on the decisions they might make in response to such situations. The data indicated that although students could provide sound definitions of plagiarism, they did not always appreciate the scope of class-based activity that constitutes plagiarism. Some examples of plagiarism were regarded as less serious than others, and in contradiction with the institution's policy. Students also generally favoured more lenient penalties than provided for by policy. The purpose of the study was to ascertain first-year students' developmental needs in relation to academic honesty, plagiarism and appropriate acknowledgement of others' work.

Keywords: Academic integrity; Academic misconduct; Plagiarism

Introduction

Science and engineering students' learning experiences, ways of working and assessment tasks are often different from those of students in other disciplines. Institutional publications and 'how to avoid plagiarism' websites frequently use instructional material illustrated by the discourse and activities of students in non-scientific subjects - even though some publicized cases of plagiarism have involved the appropriation or misuse of experimental data. In the light of this, do science and engineering students make good sense of information related to plagiarism? The aim of the study reported in this paper was to explore first-year science and engineering students' understandings of the concept and manifestations of plagiarism in relation to their institution's definition, and how they apply their understandings in educational situations that they are likely to encounter. The institution is a large, multi-campus Australian university. The underlying purpose of the study was to gather information to determine the particular needs of science and engineering students in the development of appropriate understandings of plagiarism and academic skills.

Literature review

How is plagiarism defined and understood?

This institution in our case study defines plagiarism in the following way:

Plagiarism means knowingly presenting the work or property of another person as one's own, without appropriate acknowledgment or referencing.

This is not unlike the definition provided by other universities, and as with other universities, there is an attempt to clarify the definition of plagiarism through further elaborations or illustrations; for example:

- a. word-for-word copying of sentences, paragraphs or computer source code from one or more sources which are the work or data of other persons (including books, articles, theses, unpublished works, working papers, seminar and conference papers, internal reports, lecture notes, tapes or works of creative art);
- b. closely paraphrasing sentences, paragraphs or themes;
- c. using another person's ideas, work or research data without due acknowledgement;
- d. submitting work which has been produced by someone else on the student's behalf as if it were the work of the student;
- e. copying or submitting computer files, in whole or in part, without indicating their origin;
- f. in the case of collaborative projects, falsely representing the individual contributions of the collaborating students where individual contributions are to be identified.

No matter how clear a definition of plagiarism might appear, it is not a universally understood or accepted concept in academia (Pincus & Schmelkin, **2003**). While elaborations (a)-(f), above, are indicative of plagiarism, they do not necessarily, on their own, constitute plagiarism. There is good argument that (a) alone is not plagiarism, although it might be an infringement of copyright. Mimicking another's (original) actions may also not be plagiarism. These examples *would*, however, be plagiarism if the copied work were displayed to another such that the second person is deceived about the origin of the work. Similarly, (b), (c) and (e) may infringe copyright, but if the act is not misrepresented to a third party, it is not likely to be considered plagiarism.

The issue of intentionality as an indicator of plagiarism contributes to uncertainty about the concept of plagiarism. The inclusion of 'knowingly', in the institution's definition, may imply that if there is no intention to cheat by way of plagiarism, then the student has not plagiarized. Another interpretation is that if the act itself is unintentional, then it is not plagiarism. Inadvertent plagiarism or cryptomnesia (Marsh *et al.*, **1997**; Defeldre, **2005**) describes situations where students believe ideas to be their own when, in fact, they had read about them previously. Unintentional plagiarism, however, is still considered by many to be plagiarism, as illustrated in this statement: 'The most common forms of plagiarism ... [were] seen to be unintentional and based on low scholarly capacity' (Parker, **2003**, p. 4). For the purpose of this paper, I have taken the position that the four key elements of plagiarism are (in italics): *copying (or using) of others' work* that (accidentally or otherwise) *deceives a third party* about *the authorship (or ownership)* of the work. I have thus not taken a position either way on intentionality, but acknowledge that it is a contentious point.

How prevalent is student plagiarism?

This question is difficult to answer because it is difficult to separate research on plagiarism from research on cheating in general. Secondly, most of the data are survey-based and self-reported, and hence may be inherently unreliable. However, a review of the work of a number of authors who have summarized findings from numerous research studies (McCabe & Trevino, **1997**; Walker, **1998**; Harding *et al.*, **2001**; Carroll, **2002**; Park, **2003**; Ercegovac & Richardson, **2004**) reveals that, in general:

- Academic dishonesty is widespread and appears to be increasing (results reporting in excess of 50% of undergraduate students admitting cheating are common);
- The prevalence of plagiarism is likely to be greater than what is reported;
- Cheating and plagiarism are more prevalent in some disciplines.

Recent evidence also indicates that academic staff underestimate the prevalence of cheating and plagiarism (Brimble & Stevenson-Clarke, **2005**). Studies such as this, and in all probability supported by the mass media attention given to such reports (see e.g. Illing, **2003**; O'Riordan, **2005**), is prompting universities to investigate their own students' practices, review academic misconduct policies and/or develop better programs for educating students.

Why do students plagiarize?

Various reasons for student plagiarism are offered in the literature, among them lack of time to complete the task or poor time management skills; insufficient reward for (perceived) effort or desire for efficiency; over-full curricula; fear of a poor mark or of disappointing others; the perception that they can 'get away with it'; or the desire to defy authority (Harris, **2002**;

Park, 2003). However, while most students know that plagiarism is wrong, they often do not fully understand the various actions that constitute plagiarism (McCabe & Trevino, 1996).

In general, students do not regard plagiarism as a particularly serious misdemeanour. McCabe and Trevino (1996) report disturbing results such as: 52% of students did not think that fabricating/falsifying bibliographies was serious cheating and 80% did not think that submitting work done by someone else was serious cheating. Barrett and Cox (2005) found that students were much more accepting of collusion because this involved 'learning', whereas there was a perception that plagiarism did not. Thus collusion, which is a deliberate *joint* effort to deceive a third person, appears to be understood by students as something different. Paraphrasing material from another source without acknowledgement is also considered a minor misdemeanor (Sheard *et al.*, 2002). Similarly, there is evidence that students do not regard plagiarism as seriously as do staff (Ashworth *et al.*, 1997; Pincus & Schmelkin, 2003; McCabe, 2004; Brimble & Stevenson-Clarke, 2005). The data in Table 1 (McCabe, 2004) show the percentage of students and staff who rated different categories of cheating as 'moderate to serious'. The discrepancies between them for the categories of collaboration, written 'cut & paste' and Internet 'cut & paste' highlight the differences between staff and students' views. In an Australian study, students tended to rate the falsification of research data of low importance, in stark contrast with the views of academic staff (Brimble & Stevenson-Clarke, 2005).

Table 1. Percentage of students and staff who rated the different categories of cheating as 'moderate to serious' (McCabe, 2004)

Type of cheating	% of students	% of staff
Copy on exam/crib notes	90	98
Plagiarism	91	98
Collaboration	29	82
Written 'cut & paste'	55	79
Internet 'cut & paste'	56	81
Paper from 'paper-mill'	91	98

An important factor not considered in many studies that ask students to report involvement in plagiarism is an assumption that students have the same notions of plagiarism as academics, whereas this may not be the case. Ashworth *et al.* (1997) found that although students saw plagiarism as a moral issue, it was underpinned by values and ethics such as friendship, interpersonal trust and peer loyalty, which led students to regard some forms of plagiarism as justifiable. Students also saw plagiarism simply as a need for referencing to comply with 'academic etiquette' rather than actions compromising assessment. Others point out that students in higher education often struggle with course demands, unfamiliar language and conventions, and an environment they find intimidating (Bufton, 2003). The conventions that underpin academic integrity and scholarly writing are often complex and cultured, with the result that students new to higher education, particularly those from other cultures, may find the conventions incomprehensible (Ashworth *et al.*, 2003). In an Australian study, students from overseas, whether studying in Australia or studying offshore, found it easier to justify plagiarism than Australian onshore students (Gururajan & Roberts, 2005). There is also evidence that students do not perceive their role at university as a scholarly one, but as a trainee for a particular occupation (Green *et al.*, 2003), and hence they do not identify with the academic culture into which they are being inducted. Adding to the confusion is that instances of plagiarism in society - e.g. speech- and ghost-writing - appear acceptable, whereas similar actions in academia are condemned (Martin, 1994).

What do we know of science and engineering students' knowledge of plagiarism?

Few studies investigating discipline-based students' understandings or prevalence of plagiarism have focused on physical science or engineering students. A UK study (Newstead *et al.*, 1996) revealed cheating (including plagiarism) to be more prevalent among science, engineering and technology students compared with those in other disciplines, and an investigation into the use of a Google search engine to locate plagiarism in Master's theses incidentally revealed that the highest rates of 'potential plagiarism' occurred in science, engineering and technology theses (McCullough & Holmberg, 2005). An Australian study that compared the incidence of cheating (including plagiarism) among first-year engineering

students in two institutions (Sheard *et al.*, **2002**) found that 85% and 69% of the cohorts respectively admitted to cheating in some way.

In a review of academic dishonesty among engineering students, Harding *et al.* (**2001**) reported evidence of widespread cheating, although the specific incidence of plagiarism was not singled out. The length and heavy content of engineering courses was thought to contribute to the problem. Engineering is also a male-dominated discipline and there is evidence that such behaviours are more acceptable to males than females (Underwood & Szabo, **2003**). Chemistry students' tendency to report (or not) acts of academic dishonesty (Simon *et al.*, **2004**) were also found to be based on gender, with female students more likely to report academic dishonesty and male students more likely to ignore or condone plagiarism.

Thus it appears that plagiarism is probably more prevalent and/or more acceptable to students in science and engineering programs and that in order to design intervention strategies, better knowledge of the way that these students think about plagiarism would be a useful starting point. Most students in higher education receive some literature or warning advice on plagiarism, cheating and collusion, and the need to acknowledge others' work. Assignment work for first-year physical science and engineering students is largely calculation or interpretative problems or laboratory reports of work often completed in groups. In the first year, they would seldom be required to submit extended written assignments. The information that they draw on for assignment work is likely to come from textbooks, experimental apparatus (laboratory work), quantitative research reports or their own lecture notes. The Internet may also be used for information, depending on the discipline. Some of the material consulted would display referencing and some would not. When students are required to consult fully referenced empirical research literature, they are likely to find complex ideas bound up in mathematical representations and complex text.

Method

Instrument

A survey was prepared and trialled with 30 third-year or honours students. The revised survey was then administered to students during communication skills classes. About half completed the survey in semester 1 and half in semester 2. A total of 190 of the 198 distributed surveys were suitable for analysis.

The survey asked students to (1) define plagiarism, (2) say what penalties should be applied for plagiarism and (3) make judgements about six scenarios involving plagiarism. The scenarios and interpretations (Table 2) were developed to represent different elements of plagiarism (based on the institution's elaborations) and were embedded in activities familiar to science and engineering students. The interpretations are those of the author. Decisions about plagiarism are often confounded by mitigating circumstances, such as the experience of those involved, their knowledge of scholarly conventions and the clarity of assessment instructions, to name a few. There is also an ill-defined line between what some regard as a legitimate learning activity and an attempt to compromise the assessment process. The scenarios and interpretations may be similarly contentious. The intention was to explore students' thinking and decision-making processes when confronted by varying degrees of plagiarism. Students were also given the opportunity to explain their responses.

Table 2. Description of each scenario, its relation with the institution's statement on plagiarism and interpretation of the nature of the plagiarism illustrated

Scenario and relation to the institution's definition and elaborations (a)-(f) of plagiarism	Interpretation: based on four elements of plagiarism: <i>copying</i> (or using) <i>others' work</i> that <i>deceives a third party</i> about the <i>authorship</i> (or ownership) of the work
<p>1A. <i>Jack and Jill spend time every week discussing assignment problems. Together they usually produce a rough draft of answers and then each uses this to write out answers to hand in</i></p>	<p>Some academics would not classify this as plagiarism, but a legitimate way of learning. The line between collaborative learning and copying is fine one (Barrett & Cox, 2005), and in the sciences the debate might rest on whether collaborative development of solutions to well-defined problems is the same as simply discussing ideas. It is the process of problem-solving (frequently in mathematical representations) that is usually being assessed rather than presenting the right answer</p>
<p>Elaborations (c) and (d)</p>	<p>This scenario differs from 1A, in that it emphasizes deception. Copying part of others' assignments is probably prevalent; students who are short of time (for whatever reason) may resort to what they see as an easy way of resolving their situation</p>
<p>1B. <i>One week, Jack is sick, and although they produce a rough draft, he eventually copies Jill's answers to hand in. He changes a few things, so that their work is not completely identical</i></p>	<p>Elaborations (a), (c) and (d)</p>
<p>2. <i>In a second-year lab, students work in groups of four but are required to hand in individual reports. For one practical exercise, Weng enters the group's data into a spreadsheet and produces a set of graphs, which he emails to the others. They discuss their results and write their own reports but include the graphs without acknowledging that Weng did all the graphing</i></p>	<p>The students appear to have made a pragmatic decision to efficiently distribute workload and, clearly, the data belonged to them all. The issue is whether or not the production of the graph was an important element in the assessment process. If this group had been given instructions to do the graphing themselves, then they have plagiarized the work of a fellow student. As this is not specified, the meaning of 'individual reports' is subject to interpretation</p>
<p>Elaborations (c) and (d)</p>	<p>Mary has plagiarized the work of an unknown or unrecognized author through lack of acknowledgment. This type of plagiarism appears common. Thus the scenario may illustrate laziness on the part of the student in not seeking the author's name, or making the assumption that if the name is not there, citation is unnecessary</p>
<p>3. <i>In researching an assignment topic, Mary finds relevant and useful information on a website but there is no indication of who the author is. Because this information is not available, Mary believes that she can 'cut and paste' sections from the website without acknowledging the author</i></p>	<p>Elaborations (d) and (e)</p>
<p>4. <i>In writing out a review of literature for an assignment, Harry includes some complex ideas of a particular author. He starts to write the three paragraphs in his own words but ends up copying most of them, because he doesn't know what other words to use. He references the source of his information</i></p>	<p>This is plagiarism, but of a type that first-year students might not understand fully. Paraphrasing is a complex skill, and it is simplistic to say that it is 'putting it into your own words'. The scholarly process of synthesizing ideas from several sources or presenting one's own views of the ideas or words of others can be difficult even for postgraduate students, and particularly difficult for NESB students. The complex words, expressions and ideas of science and engineering, frequently including mathematical expressions, must contribute to students' difficulties</p>
<p>Elaborations (a) and (b)</p>	<p>Since Zoë has not claimed the work as her own and was simply listing information, many would not accuse her of plagiarism as much as substandard work. However, given her experience, one might expect due acknowledgement of the authors whose work and results were probably</p>
<p>5. <i>Zoë, a third-year student, submits a lab report in which she is required to include information about the results of similar published and relevant experiments. She lists a range of other results and, at the end of the report, lists all sources</i></p>	

Scenario and relation to the institution's definition and elaborations (a)-(f) of plagiarism	Interpretation: based on four elements of plagiarism: <i>copying</i> (or using) <i>others' work</i> that <i>deceives a third party</i> about the <i>authorship</i> (or ownership) of the work
<i>from which she got the information. She is not specific about the authors/researchers who obtained each set of results</i>	scientifically significant and no different from other forms of intellectual output
Elaboration (c)	
6. <i>A group of students completes a six-week practical research assignment and submits a single report. The group must also estimate the relative contribution of each member to the research and report. Despite one member, Tim, having done very little work, all members state that they contributed equally</i>	This institution regards this as plagiarism. In this scenario, it has most likely occurred as a result of collusion. An important consideration here is whether or not specific guidance about determining the relative contributions of group members was provided to the group
Elaboration (f)	
Note: Elaborations (a)-(f) refer to the institution's definition of plagiarism.	

Each scenario was followed by the same set of questions:

Is/are [name of person] committing plagiarism? If yes or unsure, how serious do you think this plagiarism is?

- (a) Yes (a) Minor
(b) Unsure (b) Moderately serious
(c) No (c) Very serious

Participants

The students, in this study, were in the first year of physical science or engineering degree programs; 40% of the surveyed sample was female, and 21% listed the language normally spoken at home as 'other than English' (which will be referred to as non-English-speaking background, NESB).

Although the students' prior knowledge of plagiarism was unknown, it is reasonable to assume that they had encountered the concept of plagiarism and the Institution's position on it. All unit outlines are required to have a statement on the nature and unacceptability of academic dishonesty, including cheating, plagiarism and the fabrication or falsification of data. Some unit outlines include a URL for locating policy documents. Informative material about plagiarism (or how to not plagiarize) is provided on an information CD-ROM given to every student on enrolment, and also located on a library website. Some departments also provide guidelines or student information sessions.

Data and results

1 Students' declarative knowledge of plagiarism

Question 1: What do you understand *plagiarism* to be?

Students' written responses were categorized according to the information provided, for example:

- A: copying or using others' work.
B: copying or using others' work, without acknowledgement.

- C: copying or using others' work as your own (deception).
- D: copying or using others' work as your own (deception), without acknowledgement.
- E: Not representing plagiarism.

Category D represents the most complete definition, although category C encompasses the essential elements of plagiarism. Category B also includes simple definitions that, on balance, amount to plagiarism. Some 46% of students expressed a good understanding of the elements of plagiarism (categories C and D); and a further 41% focused more on the lack of acknowledgement of copied work (category B) than on deceptively presenting work as one's own for personal gain (Figure 1). Students providing responses categorized as A or B may have understood plagiarism to involve deception but this was not articulated. Only 12% of students did not provide an adequate description of plagiarism (categories A and E).

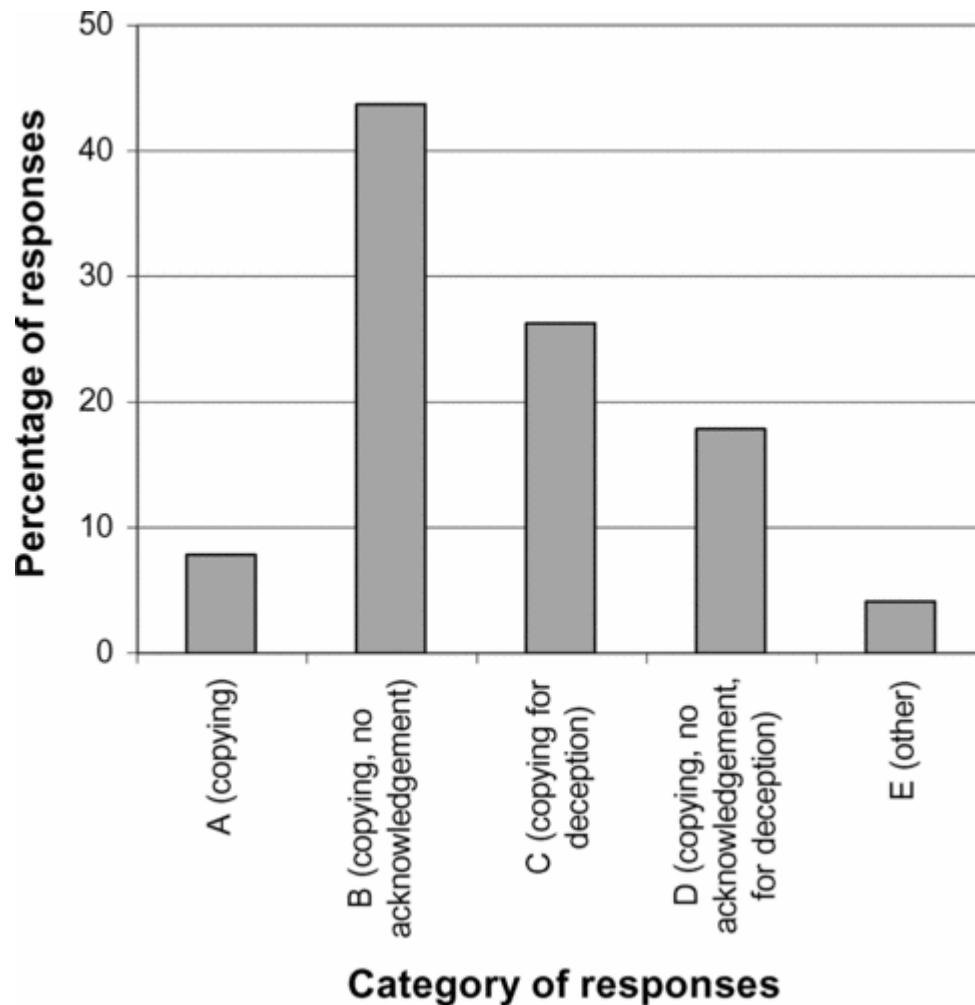


Figure 1. **Students' written responses to the question: 'What do you understand plagiarism to be?'**

2 Students' views on penalties for plagiarism

Question 2: If a student is found to have plagiarized, what penalty is appropriate? (*choose one*)

- (a) Strictly as directed by university policy.

- (b) Mandatory loss of marks.
- (c) Optional loss of marks (as determined by the lecturer).
- (d) A warning only.

Overall, students believe that a penalty is warranted for (what they believe to be) plagiarism, but only 38% wanted strict adherence to university policy (choice (a)) (Figure 2). When the cohort is split into subgroups, variations emerge (Figure 3). NESB students appear to favour less harsh penalties (choices (c) or (d)) than English-speaking students, and males appear to favour less harsh penalties than females

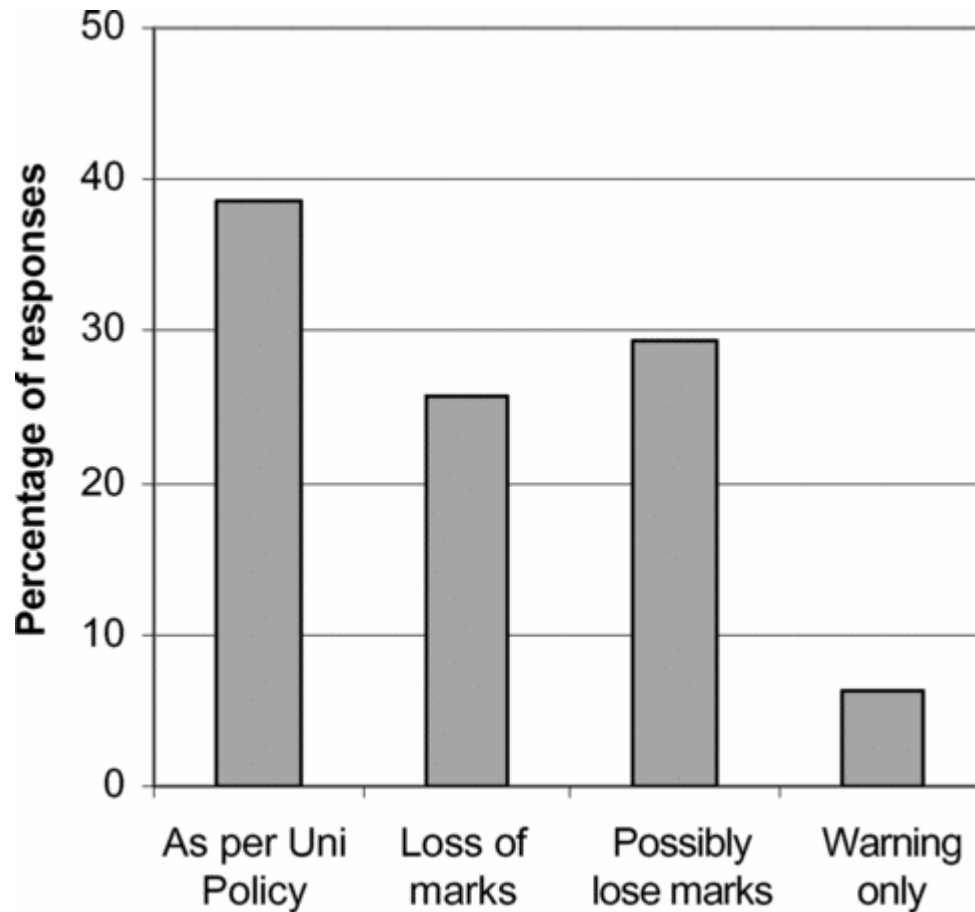
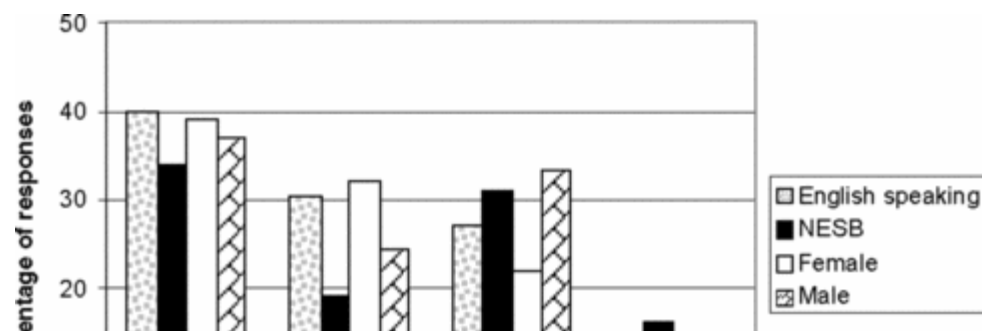


Figure 2. Student responses to the question: 'If a student is found to have plagiarized, what penalty is appropriate?'



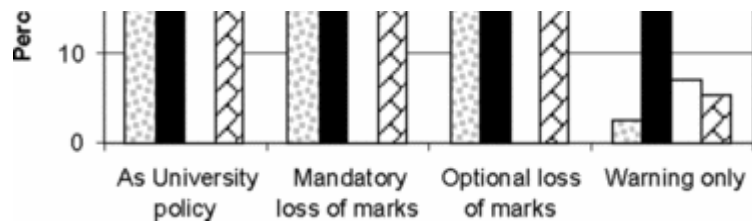


Figure 3. Frequency of subgroups of students' responses to the question: 'If a student is found to have plagiarized, what penalty is appropriate?'

3 Student classification of plagiarism in the scenarios

The data presented in Figure 4 are the proportions of students who classified each scenario as *not* plagiarism. The two scenarios that were most frequently classified this way were 1A and 6. Each is discussed further under the relevant scenario heading. Figure 5 shows how students rated the degree of seriousness of each act of plagiarism - i.e. the students who classified the act as 'yes' (plagiarism) or 'unsure' also rated how serious the offence was. Scenarios 1A and 6 appear to be regarded as less serious than the others, and scenario 3 was regarded as the most serious.

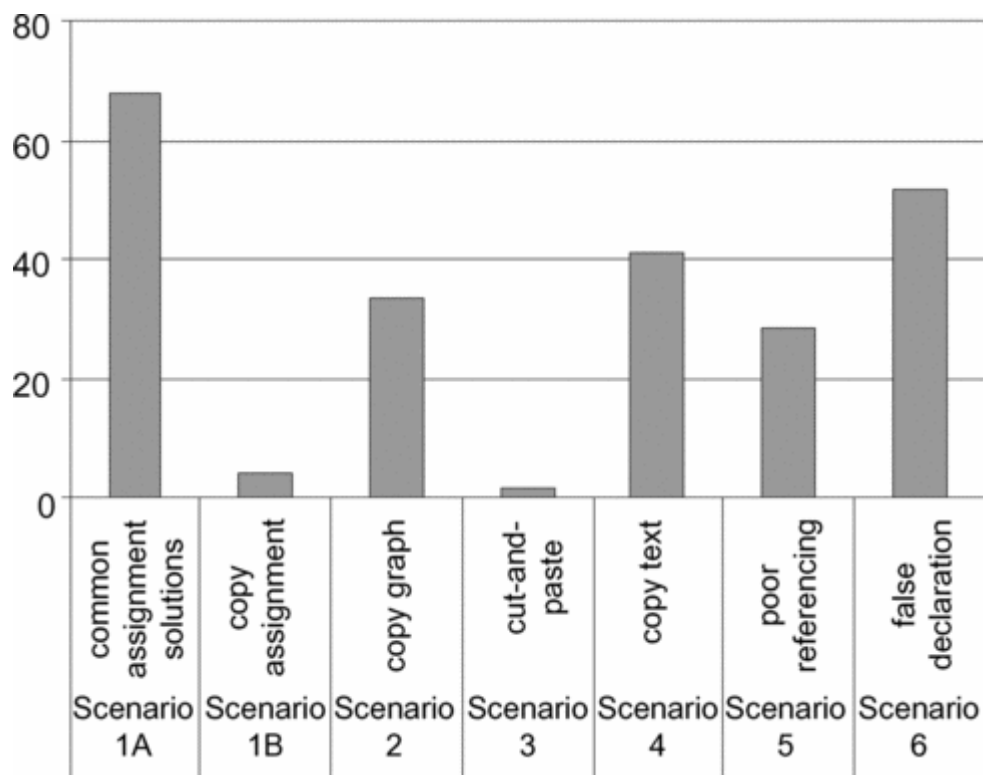


Figure 4. Percentages of students (N = 190) classifying the scenario as 'not plagiarism'



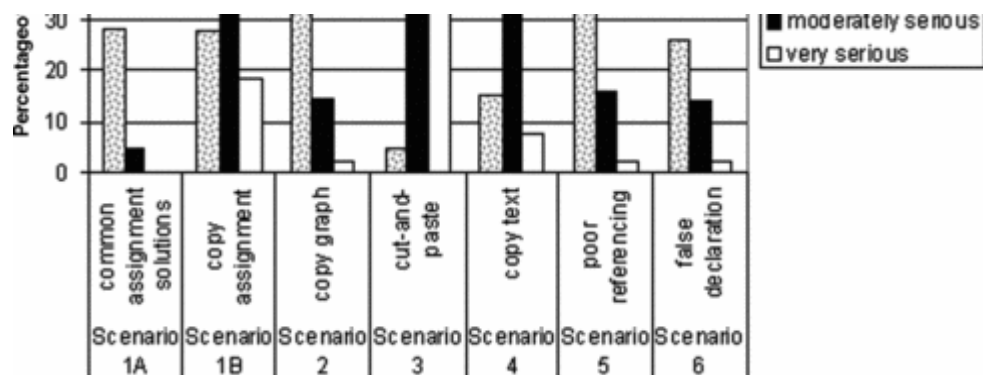


Figure 5. Percentages of students (who classified each scenario as plagiarism or unsure), who then rated the seriousness of the plagiarism in each scenario as minor, moderately serious or very serious

4 Discussion of each scenario

Scenario 1A: Jack and Jill develop common assignment solutions

Two-thirds of these students classified this as not plagiarism; one-third were either unsure or thought that it was plagiarism. Their uncertainty appears to stem from whether or not it is acceptable to work together to develop solutions to problems. Students who classified this as plagiarism offered reasons such as: J and J collaborated and therefore they could not fairly claim that the work was their own, or J and J got to the point of working out 'the answer' and so this was 'collusion'. One student stated that contributing to the draft of a written answer was acceptable but mathematical solutions were different. Thus, although a minority of these students saw both sides of the issue, most believed this was not plagiarism.

Scenario 1B: Jack copies Jill's assignment

Most students (85%) identified this as plagiarism, with a further 10% unsure. Of these students, 68% classified it as either 'very serious' or 'moderately serious'. One student thought that it would be plagiarism for humanities but not for mathematics - suggesting a view that rules can be interpreted differently for mathematics students. Another student provided a rationalization about science assignments: 'As it is only an assignment problem, it is not very serious plagiarism.' In general, however, first-year science and engineering students recognize that this represented plagiarism.

Scenario 2: Students copy Weng's graph

Opinions on this scenario were evenly divided, with approximately one-third of students choosing each alternative. Of those responding 'yes' (plagiarism) or 'unsure', 74% thought it was a minor offence only. One student said it was not serious because 'they are only graphs', suggesting either that quantitative work is different from text-based work or that this was considered only a small part of the report. Of those classifying it as plagiarism, most focused on producing the graph. Of those who classified it as not plagiarism, most focused on the joint ownership of the data: 'As a group, they are expected to work together to produce appropriate documents for their reports.' Some students acknowledged the lack of assessment criteria and offered salient advice.

Scenario 3: Mary cuts-and-pastes from website

Students, in this study, expressed very clearly that this was plagiarism (94%), with the majority of those (60%) classifying it as 'very serious'. Some pointed out that a URL is an appropriate way to reference a site when no author can be identified.

Scenario 4: Harry copies text word-for-word

As with scenario 2, students were uncertain about how to classify this, with only about one-third classifying it as plagiarism. Of the students choosing 'not plagiarism' (40%), almost all defended Harry, indicating that his attempt to reference the source precluded it from being plagiarism - i.e. these students regarded the 'plagiarism' as unintentional and therefore not plagiarism:

He referenced the source of info, so therefore did not commit plagiarism.

As long as the reader is aware ... that the ideas belong to a second person, then Harry isn't stealing credit from the actual author.

He referenced where he got the ideas and paragraphs from.

Harry ... has attempted to rewrite the paragraphs in his own words.

Students' responses often treated citing and referencing as equivalent, and some suggested that Harry should have 'just used quotation marks' and quoted the three paragraphs verbatim. There is thus evidence among these students of only a basic understanding of the concept of using others' ideas and paraphrasing.

Scenario 5: Zoë references inadequately

Students were, again, unsure about how to classify this situation, with roughly one-third choosing each alternative. One student commented: 'Depends if bad referencing is counted as plagiarism.' None made reference to the experience of the student (as a 3rd year) as a reason for expecting a higher standard of attribution.

Scenario 6: Group members claim equal contribution

Very few students thought of this as plagiarism, and of those who said 'yes' (plagiarism) or 'unsure', 61% thought it was minor only. As others have found (Ashworth *et al.*, 1997), students were perplexed that this might be considered plagiarism, with most identifying ethics or values such as 'teamwork', 'truth' or 'fairness' as the issue, not plagiarism:

Since Tim has contributed ... it's teamwork ... no matter how much he has contributed.

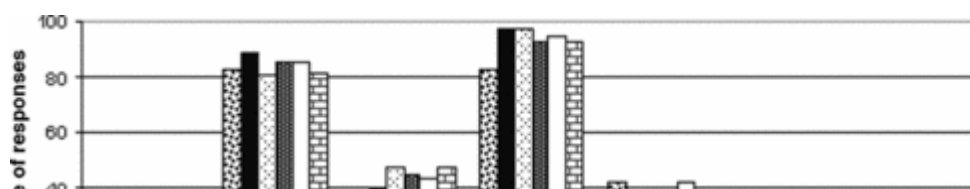
It is their work, they can say whoever they want did it.

Tim is the one committing plagiarism, the others are just not telling the truth.

It is unfair, but it is not plagiarism.

There was some conjecture about what constituted equal contribution, with some students recognizing that leadership or generation of ideas can be as important as other more tangible forms of work: 'although Tim might of [sic] done little work, he might of [sic] done key work.' Peer loyalty also surfaced: 'no one really wants to rat on a mate', although sympathy was not always with the perpetrator: 'Tim is just lucky the others didn't dob him in.' One student, on the other hand, considered that: 'Tim may not have wanted to take credit for other members' work', raising the issue of group decision-making and coercion.

Students' knowledge about plagiarism (according to the definition they provided) appears to have had little bearing on whether or not they classified each of the scenarios as plagiarism (Figure 6). Students who did not provide a good definition made similar choices to those who did. Likewise, cultural background (NESB) and gender of the students did not appear to influence their views, with the possible exception of the classification of scenario 6, which few NESB students classified as plagiarism.



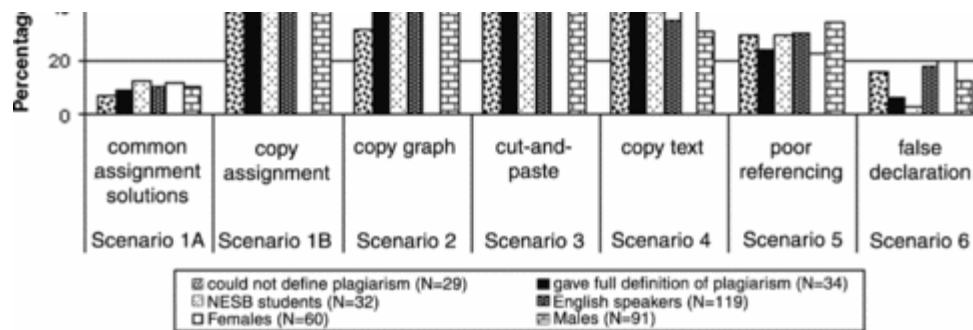


Figure 6. Percentages of students, in three pairs of subgroups, who classified each scenario as plagiarism.

Discussion

There is a growing literature on the views of students concerning plagiarism, but few have revealed the particular views of science and engineering students in relation to their type of work. This study shows that these students display many of the beliefs commonly reported elsewhere, but several observations suggest that science and engineering students have some unique needs.

Students' knowledge of plagiarism

Most students provided an adequate to good definition of plagiarism, but their understandings of actions that constitute plagiarism were varied. Only two acts (copying an assignment and Internet cut-and-paste) were considered serious examples of plagiarism. Both involve deliberate deception. Forms of collusion resulting in plagiarism (scenarios 1, 2 and 6) were seldom described as anything more serious than 'working together'. It is possible that students' opinions on scenario 1A are influenced by their perceptions of why they do these types of assignments; for science students getting the 'right answer' is usually more important than presenting the argument (Gunstone, 1995). Most students also apparently assume that it must be intentional to be plagiarism.

Where a scenario employed a key word from a definition of plagiarism, such as 'copying' or 'without acknowledging' (scenarios 1B and 3), students were more likely to classify and comment on the situation as plagiarism. However, when these words were absent or if the situation was not one commonly recognized as plagiarism, students tended to resort to their own ethical or moral judgement to formulate a response. Occasionally, this resulted in students taking a condemnatory position but more often they suggested leniency or even justification for the students' actions, for example, one student commented about scenario 6:

Technically, only Tim is committing plagiarism. I know you want me to say yes, but the fact is that the other group members completed their own work and didn't copy off anyone.

While the following conclusions are not precise, they summarize how these students, in general, rated each scenario:

- Scenario 3 (cut-and-paste) is serious plagiarism.
- Scenario 1B (copy an assignment) is moderately serious plagiarism.
- Scenario 4 (copy text) is probably moderately serious plagiarism.
- Scenario 2 (copy graph) is probably plagiarism, but only minor.
- Scenario 5 (poor referencing) is possibly plagiarism, but only minor.
- Scenario 6 (false declaration about group work) is probably not plagiarism, but if it is, it is only minor.
- Scenario 1A (work together on assignment) is probably not plagiarism, but if it is, it is only minor.

Given that scenario 6 is explicitly referred to in institutional documents as plagiarism, these students seemed largely unaware of it. Such provisions need to be communicated more effectively to students. Similarly, students (and possibly staff) need clear guidelines on the boundaries of collaborative work. If collaboration is encouraged, one must question the validity of summatively using marks derived from the submitted work for the individuals concerned.

Students' views on penalties

Many students did not favour penalties for plagiarism being in strict accordance with institutional policy. It is perhaps indicative of students' views that plagiarism is not a particularly serious act that they believe lecturers can make *ad hoc* decisions ('optional loss of marks') rather than conform to formal procedures. Open to more conjecture is the possibility that some students, in responding to the survey, recognized their own behaviours being described and responded defensively. The preference of NESB students for less severe penalties may be because they feel at a disadvantage working within rules that are unfamiliar or difficult to understand. The apparent preference of male students for less severe penalties is consistent with other research (see e.g. Underwood & Szabo, **2003**). Given that male students are in the majority in engineering, in particular, a concerted approach to informing students about due process and penalties for plagiarism appears warranted.

Students' perceptions about science and engineering assessment

There is some evidence that science/engineering students think that their assignments or laboratory reports are subject to academic rules that are different from other types of student work. There is also some evidence that these students are not concerned about small amounts of plagiarized material ('only a graph') or the importance of some assessment types ('only an assignment problem').

Most students appear to have only basic notions of paraphrasing, in support of the view that it is 'putting it in your own words'. Over the duration of their course, their ideas about paraphrasing must change from this simplistic notion towards more sophisticated, scholarly understandings. Unless periodically required to carry out learning tasks incorporating paraphrasing, science and engineering students are likely to reach a stage where they need to do it appropriately and are unable to without attracting criticism of plagiarism, which in part might explain the finding of more plagiarism in engineering and science Master's theses (McCullough & Holmberg, **2005**).

Provision of clear assessment instructions

Scenarios 1, 2 and 6 illustrate how a lack of explicit instructions about assessment can leave students insecure or incorrect in their decision-making. This may be particularly important for first-year students who, if they lack knowledge or specific assessment experiences, appear to resort to their own moral or ethical judgement, not necessarily the academic values.

While many of these students would not have experienced group-based individual assessment, they are likely to in the future. Without specific guidance, these students are likely to take the easy or loyalty-based option of reporting equal contribution whether this was the case or not. The solution appears to be one of education and of staff being suitably prepared for having their students work, and be assessed, in groups. Students find it difficult to apportion contributory work without being given fair, objective and transparent ways of making decisions about the worth of each group member's contribution.

Recommendations

Recommendations for educating science and engineering students about plagiarism, derived from this study, include:

- First-year students should be engaged in analysis or critique of a range of science-specific scenarios that compel them to expose and test their understandings of plagiarism.
- Students must acknowledge the institution's formal ways of dealing with plagiarism and the penalties that can be imposed under its policy and procedures.
- Students will need ongoing opportunities to practice skills of attribution, referencing and paraphrasing throughout their course.
- Students need to be able to understand and differentiate between acceptable and unacceptable forms of collaboration in the context of their own work.
- Staff need to consider the ramifications of encouraging students to collaborate on assessed work in science-based subjects and to (re)consider the validity of summatively using marks derived from collaborative activity.

While these generalizations may also apply to other disciplines, they appear particularly warranted for physical science and engineering disciplines.

Conclusion

This study examined science and engineering students' knowledge of plagiarism. Given that academic misconduct is considered more prevalent in engineering and science disciplines, the study was designed to explore the phenomenon by

examining students' perceptions and judgements about plagiarism incidents through their interpretation of realistic scenarios. Students' understandings were, at times, consistent with the institution's position on plagiarism, and at other times, inconsistent and based on their own ethical or moral judgement. Further research is needed to understand the impact that such judgements might have on students' decisions about their actions in relation to assessment. It also appears that ongoing intervention through deliberate and planned education programs is necessary for these students if they are to develop views that are consistent with academic scholarship and which conform to the institution's policies.

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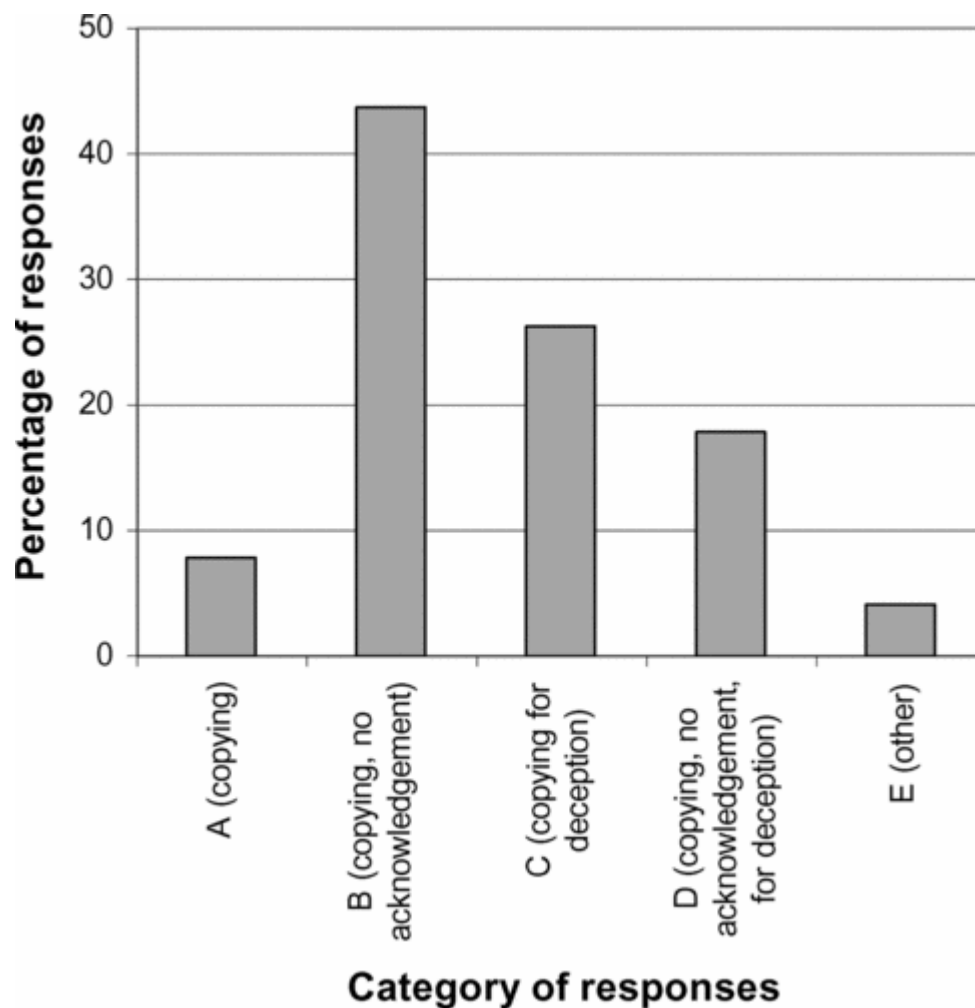


Figure 1. **Students' written responses to the question: 'What do you understand plagiarism to be?'**

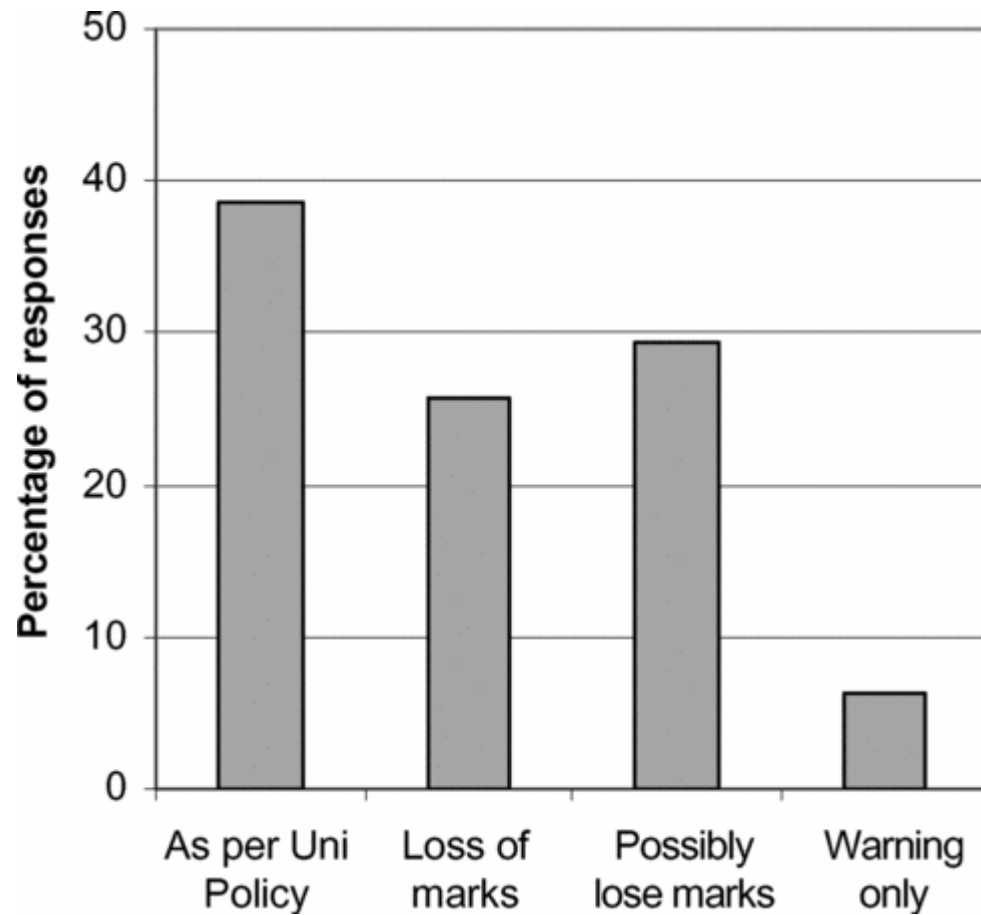


Figure 2. Student responses to the question: 'If a student is found to have plagiarized, what penalty is appropriate?'

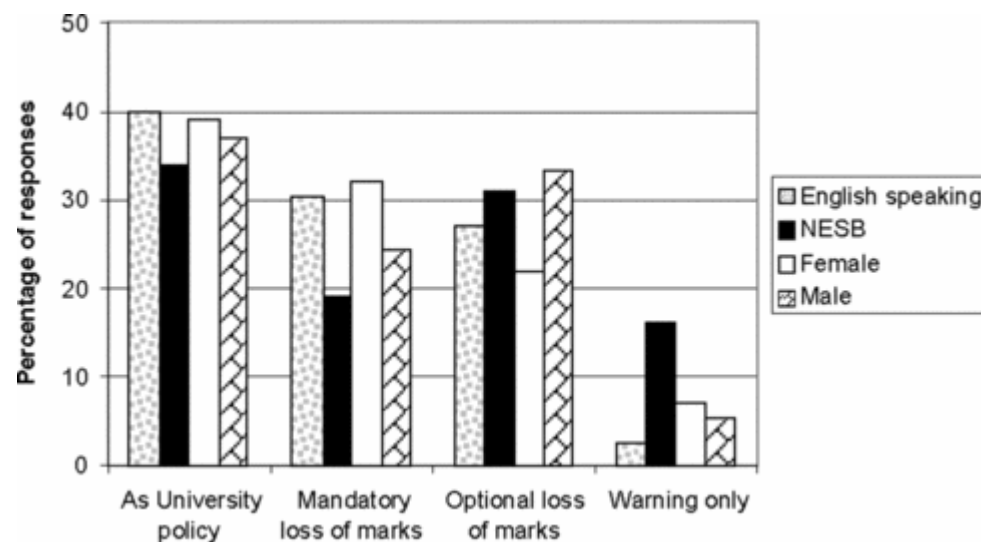


Figure 3. Frequency of subgroups of students' responses to the question: 'If a student is found to have plagiarized, what penalty is appropriate?'

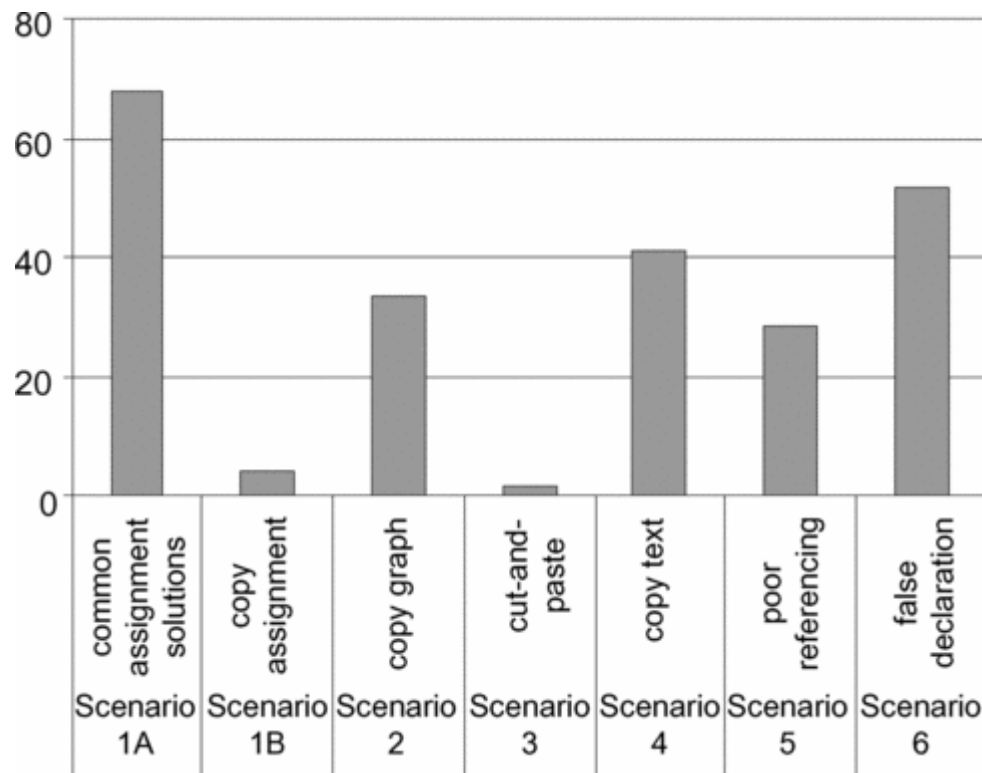
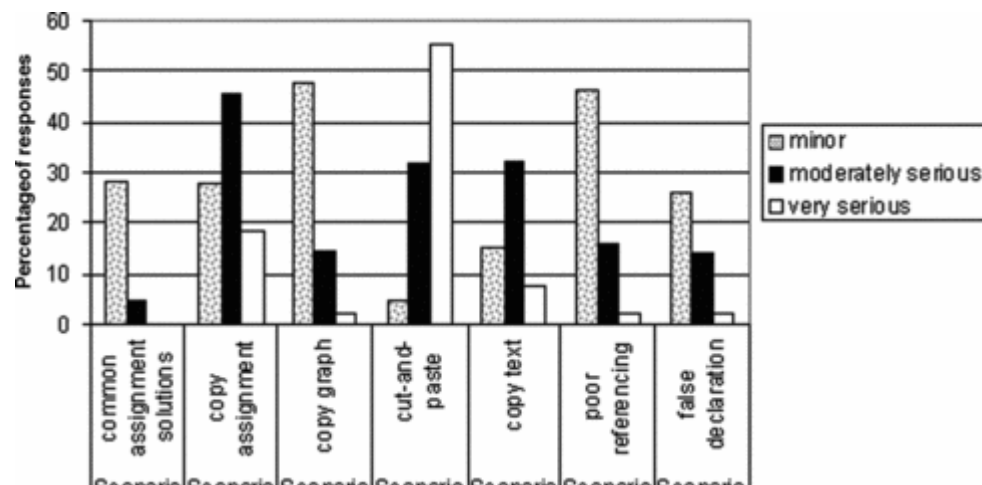


Figure 4. Percentages of students ($N = 190$) classifying the scenario as 'not plagiarism'



Scenario 1A	Scenario 1B	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
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Figure 5. Percentages of students (who classified each scenario as plagiarism or unsure), who then rated the seriousness of the plagiarism in each scenario as minor, moderately serious or very serious

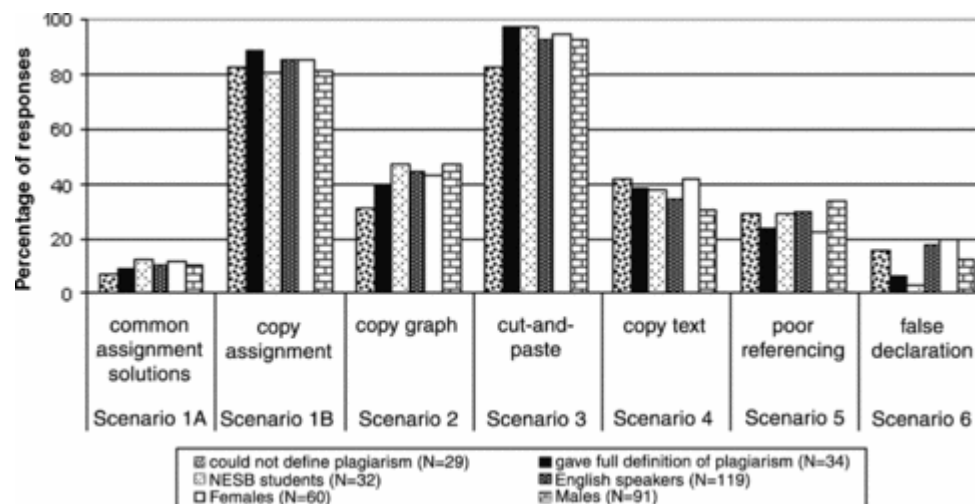


Figure 6. Percentages of students, in three pairs of subgroups, who classified each scenario as plagiarism.

List of Tables

Table 1. Percentage of students and staff who rated the different categories of cheating as 'moderate to serious' (McCabe, 2004)

Type of cheating	% of students	% of staff
Copy on exam/crib notes	90	98
Plagiarism	91	98
Collaboration	29	82
Written 'cut & paste'	55	79
Internet 'cut & paste'	56	81
Paper from 'paper-mill'	91	98

Table 2. Description of each scenario, its relation with the institution's statement on plagiarism and interpretation of the nature of the plagiarism illustrated

Scenario and relation to the institution's definition and elaborations (a)-(f) of plagiarism	Interpretation: based on four elements of plagiarism: <i>copying</i> (or using) <i>others' work</i> that <i>deceives a third party</i> about the <i>authorship</i> (or ownership) of the work
<p>1A. <i>Jack and Jill spend time every week discussing assignment problems. Together they usually produce a rough draft of answers and then each uses this to write out answers to hand in</i></p>	<p>Some academics would not classify this as plagiarism, but a legitimate way of learning. The line between collaborative learning and copying is fine one (Barrett & Cox, 2005), and in the sciences the debate might rest on whether collaborative development of solutions to well-defined problems is the same as simply discussing ideas. It is the process of problem-solving (frequently in mathematical representations) that is usually being assessed rather than presenting the right answer</p>
<p>Elaborations (c) and (d)</p>	<p>This scenario differs from 1A, in that it emphasizes deception. Copying part of others' assignments is probably prevalent; students who are short of time (for whatever reason) may resort to what they see as an easy way of resolving their situation</p>
<p>1B. <i>One week, Jack is sick, and although they produce a rough draft, he eventually copies Jill's answers to hand in. He changes a few things, so that their work is not completely identical</i></p>	<p></p>
<p>Elaborations (a), (c) and (d)</p>	<p></p>
<p>2. <i>In a second-year lab, students work in groups of four but are required to hand in individual reports. For one practical exercise, Weng enters the group's data into a spreadsheet and produces a set of graphs, which he emails to the others. They discuss their results and write their own reports but include the graphs without acknowledging that Weng did all the graphing</i></p>	<p>The students appear to have made a pragmatic decision to efficiently distribute workload and, clearly, the data belonged to them all. The issue is whether or not the production of the graph was an important element in the assessment process. If this group had been given instructions to do the graphing themselves, then they have plagiarized the work of a fellow student. As this is not specified, the meaning of 'individual reports' is subject to interpretation</p>
<p>Elaborations (c) and (d)</p>	<p></p>
<p>3. <i>In researching an assignment topic, Mary finds relevant and useful information on a website but there is no indication of who the author is. Because this information is not available, Mary believes that she can 'cut and paste' sections from the website without acknowledging the author</i></p>	<p>Mary has plagiarized the work of an unknown or unrecognized author through lack of acknowledgment. This type of plagiarism appears common. Thus the scenario may illustrate laziness on the part of the student in not seeking the author's name, or making the assumption that if the name is not there, citation is unnecessary</p>
<p>Elaborations (d) and (e)</p>	<p></p>
<p>4. <i>In writing out a review of literature for an assignment, Harry includes some complex ideas of a particular author. He starts to write the three paragraphs in his own words but ends up copying most of them, because he doesn't know what other words to use. He references the source of his information</i></p>	<p>This is plagiarism, but of a type that first-year students might not understand fully. Paraphrasing is a complex skill, and it is simplistic to say that it is 'putting it into your own words'. The scholarly process of synthesizing ideas from several sources or presenting one's own views of the ideas or words of others can be difficult even for postgraduate students, and particularly difficult for NESB students. The complex words, expressions and ideas of science and engineering, frequently including mathematical expressions, must contribute to students' difficulties</p>
<p>Elaborations (a) and (b)</p>	<p></p>
<p>5. <i>Zoë, a third-year student, submits a lab report in which she is required to include information about the results of similar published and relevant experiments. She lists a range of other results and, at the end of the report, lists all sources</i></p>	<p>Since Zoë has not claimed the work as her own and was simply listing information, many would not accuse her of plagiarism as much as substandard work. However, given her experience, one might expect due acknowledgement of the authors whose work and results were probably</p>

Scenario and relation to the institution's definition and elaborations (a)-(f) of plagiarism	Interpretation: based on four elements of plagiarism: <i>copying (or using) others' work that deceives a third party about the authorship (or ownership) of the work</i>
<i>from which she got the information. She is not specific about the authors/researchers who obtained each set of results</i>	scientifically significant and no different from other forms of intellectual output
Elaboration (c)	
6. <i>A group of students completes a six-week practical research assignment and submits a single report. The group must also estimate the relative contribution of each member to the research and report. Despite one member, Tim, having done very little work, all members state that they contributed equally</i>	This institution regards this as plagiarism. In this scenario, it has most likely occurred as a result of collusion. An important consideration here is whether or not specific guidance about determining the relative contributions of group members was provided to the group
Elaboration (f)	
Note: Elaborations (a)-(f) refer to the institution's definition of plagiarism.	