A Simple Way to Cultivate Referencing Habits in First Year Biology Students

Prasad Chunduri[a], Lesley Lluka[a], Genevieve Kinna[a], Jonathan Good[b], Kirsten Zimbardi[a] and Kay Colthorpe[a]

Corresponding author: Prasad Chunduri: p.chunduri@uq.edu.au
[a]School of Biomedical Sciences, The University of Queensland, Brisbane QLD 4072, Australia
[b]Department of Natural Sciences, Daemen College, Amherst, NY 387 14226, USA

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Abstract

Scientific writing skills are an important aspect of undergraduate science curricula, and science careers. Learning activities and assessment tasks that are designed to enhance students' scientific writing skills place emphasis on the students' existing ability to search and cite valid references. This can sometimes be an intimidating expectation, especially for international students. This study investigated a simple way to cultivate and sustain appropriate referencing habits in first year undergraduate science students, and related these habits to academic performance. The students were enrolled at The University of Queensland (UQ), Australia, but studying at Taylor's University, Malaysia, as part of a twinning arrangement between the two institutions. This study found that careful scaffolding of practical reports and the inclusion of one challenging question per practical report was enough to significantly improve student skills in referencing and academic performance. It further found that students generally preferred to use the course textbook as their major reference, followed by a variety of sources including journal articles.

Introduction

Writing skills of science and biology graduates are consistently being highlighted as important by employers and national organisations (AAAS, 1989; Jones, Yates & Kelder, 2011). Many university students, however, remain below a threshold standard of literacy and writing on graduation and lack an understanding of the role of the peer review process as a mechanism for validating scientific discoveries and creating knowledge (Guilford, 2001; Woolley & Hatcher, 1986). Over the years, various learning and teaching strategies have been designed to address this issue, including assessments which imitate the process of peer review and publication (Gay, 1994; Guilford, 2001; Lightfoot, 1998). The majority of these strategies have focused on the senior undergraduate or graduate students (Gay, 1994; Guilford, 2001; Lightfoot, 1998; Flaspohler, Rux & Flaspohler, 2007; Porter, 2005) rather than the early undergraduate years where students form most of their writing skills (Bell, 2011; Wenk & Tronsky, 2011). The expectation of scientific writing and referencing skills can be especially intimidating for international undergraduate students who are from non-English speaking countries (Deckert, 1993; Yamada, 2003).

The aim of this study was to inculcate first year undergraduate biology students in writing and citing suitable references in their practical reports and understand how these change through the duration of semester. To do this, we measured both qualitatively and quantitatively the types of references students used in their practical reports. We did this to determine whether there was a relationship between the use of references and student

performance in the grade received for the practical reports and overall performance in the unit.

Methods

Student Cohort

The students involved in this study were enrolled in a first year undergraduate biology course at The University of Queensland, a large, research-intensive university, but were based at Taylor's University, Malaysia, during the years 2008-2010. The students were studying at an overseas campus as part of a twinning program. All students participating in this study had achieved a minimum overall band score of 6.5 (maximum test band score is 9) in the International English Language Testing System (IELTS), a widely accepted academic test for university enrolments in Australia.

Course Context

To scaffold the development of writing and referencing skills, students were set the task of writing three practical reports on the first year practicals of osmosis, action potentials and skeletal muscle. These three practicals were selected because they follow an inquiry-based approach so that students develop an understanding of the scientific process (Myers & Burgess 2003; Zimbardi & Myatt 2012). The practicals were delivered via an interactive online practical manual modified from the original *LabTutor*® program developed by ADInstruments, Sydney, Australia. In each practical, students developed a hypothesis, designed and conducted an experiment to test their hypothesis, collected and analysed data and discussed their findings. The interactive online laboratory manual provides spaces for each group to enter their hypotheses, materials and methods, and experimental data. An end-of-semester written summative examination was used to measure their understanding of key biology concepts.

In the first practical class, students formed self-selected groups of three members, and were actively encouraged to remain in these groups, with the same tutor, for all of the remaining classes. Forty eight hours after each practical class, students submitted an individual, scaffolded report. Each report contained a series of discussion questions that the students were required to answer using the results from their experiments and through a review of literature on the topic(s). Reports were assessed by their tutor who used a standard and criteria based rubric. Grades and written feedback were returned to students at least five days before the next practical report was due. Verbal feedback was also available for students following the practical class.

In 2009 and 2010 a text box called 'References' was added to the original scaffolding of the practical report. Students were asked to list all resources that they used in preparing the report, but at no stage were the students told to cite references in the discussion or elsewhere in the report. In addition, an open-ended question that asked the students to comment on the type of resources they found most useful in the development of their writing was added to the final practical report.

Data Collection

In order to study the sequential development of the students' writing skills, reports from the course BIOL1040 were analysed from three sequential practicals (also referred to as Practicals 1-3 or Reports 1-3 for the purpose of this paper) in 2008 to 2010. Generally,

Practical 1 was conducted in teaching weeks 4-5, followed by Practicals 2 and 3 in teaching weeks 6-7 and 10-11, respectively, in a typical 13-week teaching semester.

For some students, fewer than the three practical reports were available for analysis. When comparisons among practical reports were made all three reports were analysed, but when comparisons were made between years, the total number of reports available was used. For all of the reports analysed, data was collected from both the references that students included in the 'References' box, as well as those provided within other sections of the structured report.

To determine if there was a relationship between the extent of referencing and performance in course assessment, the number of references used by students was compared to the grade for the practical reports, and the overall course grade. Consent for data collection and its use in publications has been approved by the UQ Human Ethics Committee #2009000817.

Statistical Analysis

To determine whether the number of references used by students differed across the years, the number of references used by each student in each of the three practical reports in 2008, 2009 and 2010 was analysed by a non-parametric Kruskal-Wallis one-factor ANOVA followed by Dunn's multiple comparisons test.

To determine whether there were changes in the number of references used across Reports 1-3 in 2009 and 2010, two-factor repeated measures ANOVAs on the number of citations in the Discussion and the number of references in the Bibliography for those students where the reports were available for all three practical reports was carried out for each of the two years (2009 and 2010). This was followed by Friedman tests on the paired data for each student, and then Dunn's multiple comparisons test to determine between which reports the variation occurred. In addition, to determine whether there were differences between the number of citations in the Discussion and the references in the Bibliography of each report, Wilcoxon matched-pairs signed-rank tests were used.

To compare the practical grades obtained by each student across Practical Reports 1, 2 and 3 in 2009 and 2010, the paired data were analysed by a Friedman test followed by Dunn's multiple comparisons tests.

To determine whether the number of references used per practical report differed in relation to the grades (4-7) that the students obtained for the overall course in 2009, the number of references used in each of the 101 practical reports available for 2009 was analysed by a non-parametric Kruskal-Wallis one-factor ANOVA, followed by Dunn's multiple comparisons test.

For all analyses, values are presented as median ± interquartile range (IQR) and results were considered significant if $P < 0.05$. Data were analysed using *GraphPad Prism* version 6 for Windows (GraphPad Software, San Diego, CA, USA, www.graphpad.com).

Results and Discussion

A change in the practical report scaffolding prompts students to use and cite references

In 2008, no students cited any references in any practical report analysed (36 reports analysed from 12 students; Figure 1). In 2009, however, when the 'References' box was included in

the report structure, there was a clear increase in the number of reports that used references (Figure 1). Almost all reports analysed (99%) included references. In 2010 when the 'References' box was again included in the report structure the percentage of reports that used references was still high, however not as high as they were in 2009 (90 compared to 99%; Figure 1).

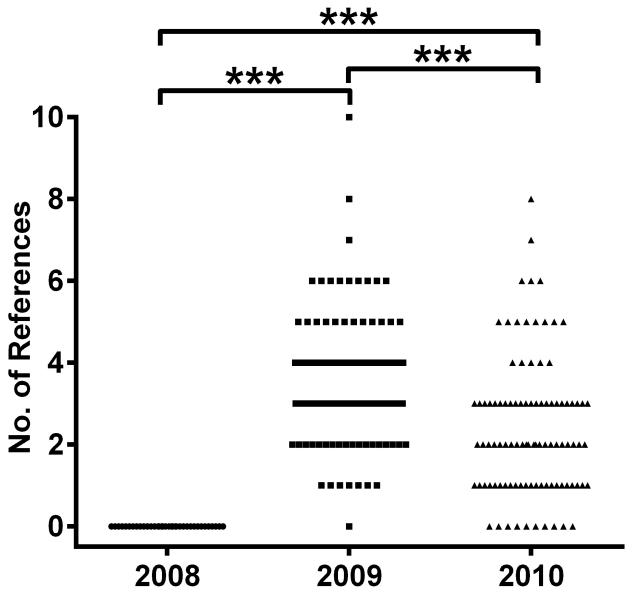

Figure 1. Scatter plot of the number of references listed per report in 2008, 2009 and 2010. The total number of reports analysed in the study from all three practical reports was 36 in 2008; 101 in 2009 and 96 in 2010. Data were analysed by a Kruskal-Wallis test ($P < 0.001$) with Dunn's multiple comparisons test to determine differences between years (*$P < 0.001$).**

In 2009 and 2010 students also cited references in answers to the discussion questions, and in other parts of the report including methods, although this was less common. Although the process of referencing for scientific writing was taught explicitly in the course throughout 2008-2010, this was not done for practical reports. Our results indicate that students did not transfer the skills in referencing developed for assessments in other parts of the course unless explicitly instructed. The addition of the 'References' box however, prompted students to list references and incorporate citations at relevant points in their reports.

Previous research carried out in Australia (Krause, Hartley, James & McInnis, 2005) and Hong Kong (Deckert, 1993) found that first year students often do not know when references are required (Krause et al., 2005). Students also do not have a clear understanding of the implications associated with referencing sources of information, or that not referencing constitutes plagiarism (Deckert, 1993). This study provides evidence that biology students are capable of initiating and successfully applying referencing habits to practical reports when explicitly requested to do so.

Although the inclusion of the 'References' box elicited appropriate referencing behaviours from most students, there was a large degree of variation in the number of sources of information that the student used. The number of references used by students (for whom all of the three practical reports were available) was analysed for the 2009 and 2010 cohorts

(Figure 2). The number of references cited ranged from 0-6 for Report 1, 1-8 for Report 2 and 1-10 for Report 3 in the 2009 cohort. In 2010, there were a similar number of references cited with 0-6 references in for Report 1, 0-7 for Report 2, and 0-8 for Report 3. Only one student in 2009, while five students in 2010, omitted references from Report 1. All students in 2009 and the vast majority in 2010 included references in Reports 2 and 3, indicating that a small number of students needed both the 'References' box in the structure of the report along with the feedback that they needed to include references in their reports. One student in 2010 did not include any references throughout the three reports, and one included one reference in Report 1, but no references in Reports 2 and 3. Taken together, the inclusion of a 'References' box in the structure of the report appears sufficient to prompt the majority, but not all students to include references. It is unclear whether the low number of references cited by some students is a true reflection that they were using very few sources in their writing, or whether these students were only citing a selection of the sources they were using. In either case, additional measures seem to be necessary to improve the range of reference sources used by students.

Shift in referencing practices throughout the semester

Referencing behaviour of students changed throughout the semester. There was a statistically significant increase in the number of references cited in the discussion and overall for both the 2009 and 2010 cohorts (Figure 2). While there was a significance increase in the number of references cited between Report 1 and 2, there was no significant difference in the number of references between Reports 2 and 3 in 2009 or 2010 (Figure 2). These findings reveal that although students increased the number of sources of information from Report 1 to Report 2, this did not continue to Report 3. After each report, students were provided with feedback but were not provided with any further instructions regarding referencing in practical reports again in semester. We initially hypothesised that the increase in the number of references between the Reports 1 and 2 represented the impact of feedback, and that the lack of an increase in the number of references between the Reports 2 and 3 was due to a decrease in student effort as assessment loads increased toward the end of semester. However, Willison and O'Regan (2005) argue that students should be provided with opportunities to address challenging questions to engage with the literature.

Although there were differences in the content of each of these reports, the maximum number of references used by students was correlated with the questions in the assessment that engaged students with the literature. For example, the number of references cited by students for Report 2 (Figure 2) was influenced by the inclusion of a specific question that required students to go beyond the material in the lectures. As a result, students searched for literature to answer this question.

The course textbook was the most frequently cited source in both 2009 and 2010 (Table 1) and a smaller number of students cited other alternative biology textbooks, followed by lecture notes, background information, and finally, peer reviewed journal articles. Up to 74% of students cited published peer-reviewed journal articles in practical report 2 (2009), however, the range was generally between 20-50% across the three reports from 2009 and 2010 (Table 1).

Student grades reflect the number of references used

Good referencing practices should be rewarded or at least reinforced, with higher grades, if the assessment is aligned with the learning objectives of the course. When the relationship between the number of references that students use in their practical reports and their grades

for the practicals was analysed, there was a correlation (Figure 3). While the grades cannot be directly linked to their referencing habits, it is possible that more reference sources in practical reports led to more in-depth discussion of experimental results and associated biological processes.

There was a significant increase in the grade for Report 2 compared with Report 1 in 2008, 2009 and 2010. There was also an increase in grade from Report 2 compared with Report 3 in 2008 and 2009, but not 2010 (Table 2). In addition, we plotted the average number of references used by students in each of their reports in 2009, against their final grade for the course (Figure 3). Students who achieved the maximum course grade of 7, cited significantly more references in their practical reports compared to students who achieved a course grade of 4 (a Pass) or 5 (Credit). This supports the idea that students who cite more references in practical reports may also correlate to high achievements in other areas of the course and a higher overall course grade. As indicated earlier, students who go beyond the course materials and cite more advanced sources such as primary literature are developing the skills for appropriate use of evidence in their disciplines and effective habits for life-long learning (Grafstein, 2002; Willison & O'Regan 2005).

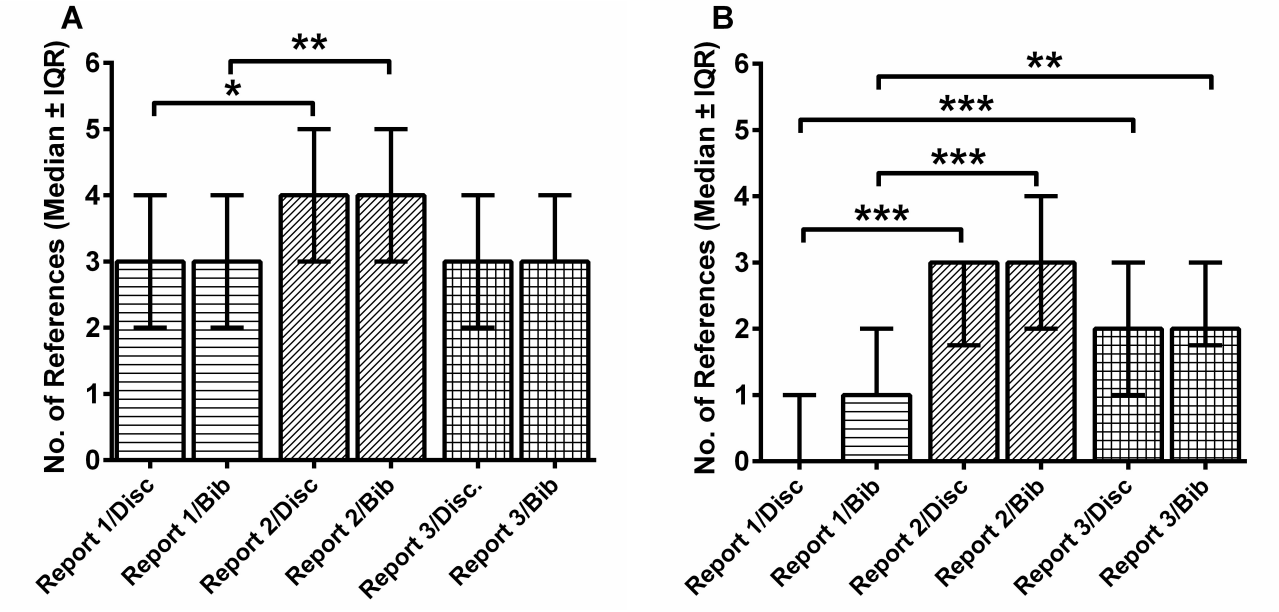

Figure 2. Median (± IQR) number of citations in the discussion (Disc) and references listed in the bibliography (Bib) in Reports 1-3 for each student for whom all three reports were available in 2009 (A; *n* = 31) and 2010 (B; *n* = 30). In cases where the IQR is the same as the median, it is not possible to show the IQR. Data were analysed using a two-factor repeated measures ANOVA (*P* < 0.001 for variation due to report number in 2009 and 2010), followed by a Friedman test (*P* < 0.01) and Dunn's multiple comparisons test comparing Reports 1, 2 & 3 (P* < 0.05; ***P* < 0.01; ****P* < 0.001).**

Table 1. The percentage of students who listed a specific resource type in their bibliography for Reports 1, 2 & 3 in 2009 and 2010. *n* = the number of student reports that were available for analysis.

Resource Type	2009			2010		
	Report 1 *n* = 35	Report 2 *n* = 34	Report 3 *n* = 32	Report 1 *n* = 33	Report 2 *n* = 31	Report 3 *n* = 32
Course textbook: Campbell *et al.*, 'Biology'	83%	71%	84%	67%	77%	91%
Background information (an online information sheet about the upcoming practical available to the students before and after the practical class)	3%	32%	44%	0%	23%	50%
Course lecture notes	20%	41%	19%	33%	61%	34%
Peer reviewed journal articles	46%	74%	50%	21%	55%	41%
Books (other than course textbook)	31%	50%	41%	9%	6%	19%
Non-peer reviewed internet sources	23%	35%	19%	12%	13%	3%

Table 2. Distribution of grades for the three reports in 2008, 2009 and 2010.

Grades for Practical Reports[a]	2008 (*n* = 12)			2009 (*n* = 36)			2010 (*n* = 33)		
	A	B	C	A	B	C	A	B	C
Report 1	0	7	5	9	26	1	7	22	4
Report 2	12	0	0***	26	7	3*	18	14	1*
Report 3	12	0	0***	33	3	0***	17	15	1^{NS}

[a]The practical reports were graded A-E and none of the students received grades of D or E on any report. The students received their graded reports before they commenced the next practical.
The data were analysed by Friedman test ($P < 0.001$ for each year) followed by Dunn's multiple comparisons test, comparing the grades for Reports 2 & 3 with Report 1 ($^{NS}P < 0.05$; $*P < 0.05$; $***P < 0.001$).

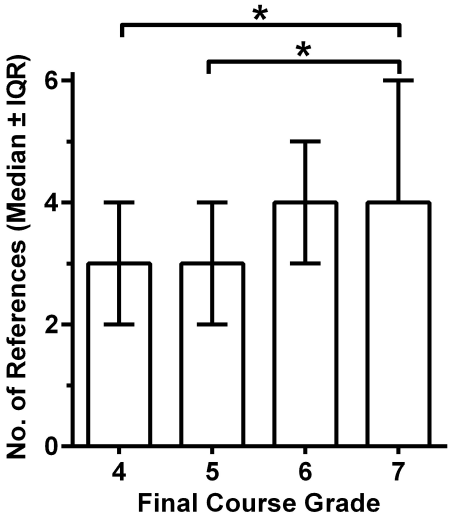

Figure 3. Median (± IQR) of the number of references used by each student in each report plotted against the student's final grade (1-7 scale, with 7 being the highest grade) for the 101 reports analysed in 2009. In cases where the IQR is the same as the median, it is not possible to show the IQR. Data were analysed using a Kruskal-Wallis test ($P < 0.01$) with Dunn's multiple comparisons test to compare results for the different course grades (*$P < 0.05$).

Conclusion

Practical reports are a common element of many undergraduate science courses. It has been previously reported, however, that the instructions students receive do not provide a clear understanding of expectations in report writing (Krause et al., 2005). It has also been reported that students are provided with vague guidelines regarding formatting, length and topic of assessments (Porter, 2005). In this study, we have described a structured approach to laboratory writing which mimics a scientific manuscript with sections including methods, results, discussion and a 'References' box. The "References" box prompted students to both list literature sources they used in the reports and cite these sources in relevant places throughout their reports. The addition of one challenging discussion question in each practical report increased the number of high level references cited by students including peer-reviewed journal articles. Our results are promising because we have demonstrated this outcome for multiple cohorts of first year international students, who find it difficult to use primary literature and learn conventions for scientific writing. While this study has focused on a detailed investigation of the nature of referencing behaviours of three small cohorts of first year biology students, we plan to undertake similar studies on some aspects of this study with larger cohorts to increase the statistical power and determine whether the relationships can be more broadly applicable.

Taken together, the findings of this study suggest two important rules of thumb for educators and curriculum design experts looking for simple and efficient ways to improve the use of referencing by undergraduate students: 1) modelling alone is not sufficient to elicit appropriate referencing behaviours from students, and 2) scaffolding in addition to modelling may be sufficient to elicit appropriate referencing behaviours from the majority of students, without the need for additional explicit instruction. Furthermore, without explicitly including the use of references in the grading criteria for the practical reports, we found that the

increased frequency and quality of sources being cited by students in Report 2 compared with Report 1 was related to grades for those reports and to overall course grade.

This study suggests that international students undertaking their first year of undergraduate university studies are generally capable of using high quality reference sources to support their course work. In addition, the study showed that the use of appropriately scaffolded practical reports significantly enhances students' use of appropriate references and that a greater degree of reference use is related to higher levels of academic performance.

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