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*Advan Physiol Educ* 31:167-175, 2007. doi:10.1152/advan.00111.2006

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## Using explicit teaching to improve how bioscience students write to the lay public

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Submitted 7 November 2006; accepted in final form 26 February 2007

**Moni RW, Hryciw DH, Poronnik P, Moni KB.** Using explicit teaching to improve how bioscience students write to the lay public. *Adv Physiol Educ* 31: 167–175, 2007; doi:10.1152/advan.00111.2006.—The media role model was recently developed to frame how science faculty members can teach their students to write more effectively to lay audiences (14). An Opinion Editorial (Op-Ed) was introduced as a novel assignment for final-year physiology and pharmacology undergraduates. This second phase of this study, reported here, demonstrated the efficacy of explicit teaching of the Op-Ed, using a one-shot, pre-/posttest research design. Baseline writing skills of students were determined from a communication assignment. Students were then explicitly taught how to write an Op-Ed and subsequently wrote an Op-Ed based on a recent, relevant scientific article. Most students achieved higher grades for their Op-Ed following explicit teaching [mean (SD) = 84.4% (9.1%),  $n = 216$ ] compared with their communication assignment [mean (SD) = 74.7% (11.9%),  $n = 218$ ]. Improvement in student writing was also evident by an increase in text readability, which mirrored the features of Op-Eds written by professional journalists. A survey of students ( $n = 142$ ) indicated that most believed that the assignments were valuable and that their ability to write to a lay audience had improved. Members of the lay public were then surveyed for their opinions on student writing. Two assignments were selected from one student whose grades had improved after explicit teaching. Respondents ( $n = 78$ ) indicated that the Op-Ed was easier to read than the communication assignment. Thus, explicit teaching of the Op-Ed improved the ability of students to write to members of the lay public.

public audience; scientific communication

CLEAR AND EFFECTIVE WRITING is integral to the progress and dissemination of modern biological advances (13). In the broader community, effective communication between professional scientists and the lay public is essential for the well being of communities, e.g., in preventing disease and promoting health (15). In this article, “lay” is defined as nonexpert in the field of bioscience, specifically, physiology and pharmacology (3). However, the often complex and specialized language used by scientists does little to assist nonexperts in understanding the content or processes of modern science (4). It is the commercial media (not professional scientists) who are most active and effective in conveying advances in science to the lay public, through, for example, Opinion Editorial (Op-Ed) newspaper articles (6).

Poronnik and Moni (14) argued that universities are well positioned to teach future scientists as to how to more effectively communicate to nontechnical audiences. In the first

phase of an action learning project, these authors developed the media role model to describe how the media acts as community gatekeepers of new scientific findings. They then used their model to frame the introduction of an innovative writing assessment task, an Op-Ed, for final-year physiology and pharmacology students. These students found the task challenging, but valuable, and further reported that their ability to write to the lay public had improved after explicit teaching and feedback around this assessment task. Most students demonstrated that they could write a high-quality Op-Ed drawn from a primary research article. However, these achievement data were only collected *after* explicit teaching of how to write an Op-Ed. Without a pretest of students’ writing, it was not possible to demonstrate an improvement in students’ writing following explicit teaching. Furthermore, opinions of the lay public were not sought, and, thus, the first phase results lacked input from the authentic target audience.

In the second phase of this project, the research team have implemented a one-shot, pre-/posttest research design (7) to explore the effect of explicit teaching on students’ ability to communicate with the lay public. “Explicit teaching” refers to a method of direct instruction whereby faculty members systematically teach elements of writing in stages so that the teaching of one aspect of writing links to and builds on the previous, resulting in the cumulative development of knowledge and skills that enable more effective communication (11). Explicit teaching was selected because recent research has revealed that science students can learn how to write specific genres through this strategy in the context of authentic use (5). In addition, the opinions of lay members of the public were sought regarding the quality of student writing before and after explicit classroom teaching of the Op-Ed genre. This phase of the study was framed around the following three research questions:

1. Does explicit teaching improve the ability of students to write effectively to a lay audience?
2. What do students think about learning to write to lay audiences?
3. Can members of the lay public recognize differences in the quality of students’ writing before and after explicit teaching?

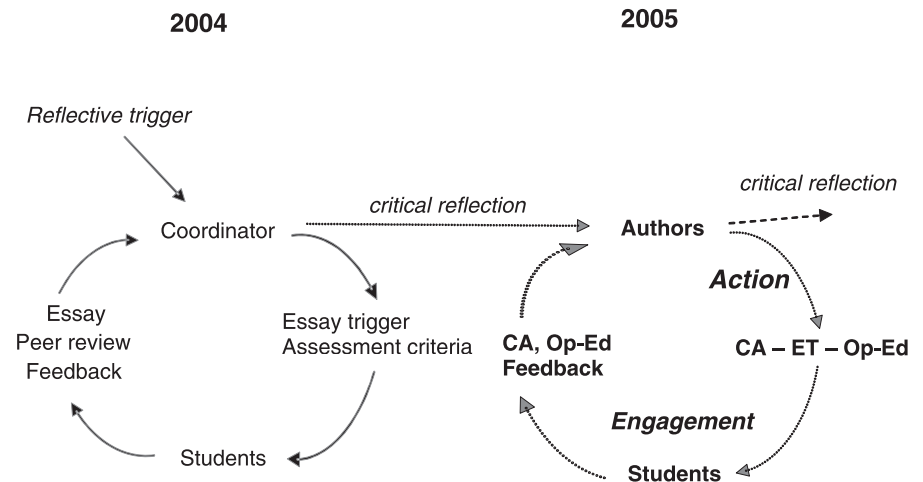
### CONTEXT AND RESEARCH METHODS

#### Context

*The action learning project.* An action learning design was adopted in this study because of the focus on improving the quality of teaching practice in physiology and pharmacology (9, 18). The articulation of the 2004 (first) phase (14) and the 2005 (second) phase reported here was framed by Kolb’s experiential learning cycle (12). For the second

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Fig. 1. Integration of the experiential learning cycles for faculty members and students in BIOM3006 from 2004 to 2005. Based on the 2004 course experience (14), the authors recognized that students achieved high grades in the Opinion Editorial (Op-Ed) assignment but that an improvement in writing following explicit teaching (ET) was not clearly demonstrated due to absence of a pretest. They then conceptualized and implemented an intervention, i.e., pretest writing via a communication assignment (CA), then explicit teaching of the Op-Ed genre, and then posttest writing using the Op-Ed assignment. Students actively engaged in learning to write by completing the assignments followed by feedback from the BIOM3006 lecturer.



phase of this project, the focus of research shifted from the introduction of the Op-Ed assessment task to the impact of explicit pedagogy of the task (Fig. 1). From the 2004 course experience, the authors recognized that most students achieved high grades in the Op-Ed assignment but that improvement in writing following explicit teaching was not clearly demonstrated. The 2005 phase was planned to include a communication assignment as a pretest of writing. Students would then be exposed to explicit teaching on writing an Op-Ed as the project intervention and subsequently required to complete an Op-Ed assignment as the posttest of writing. Student engagement in learning was supported by feedback on all assignments from the BIOM3006 lecturer. Our findings would then generate the next cycle of reflection and action by the authors to further improve the course.

*The course and students.* Human Physiology and Pharmacology in Disease (BIOM3006) is a one-semester, final-year course offered in the Bachelor of Science degree program at The University of Queensland. It is taught from the School of Biomedical Sciences. The major focus of this course is to understand the physiological changes that underlie important human disease states and the pharmacological/genetic strategies used in their treatment. Students are required to integrate their knowledge from second- and third-level courses in physiology and pharmacology to consolidate an understanding of the interrelationship between the different disciplines in solving disease states. This is complemented by the goal to develop students' communication skills. There were 224 students enrolled in BIOM3006 in the Spring semester of 2005.

*The communication assignment.* To measure students' ability to write to lay audiences before the explicit teaching intervention, the

students individually completed a short written task ( $400 \pm 10\%$  words) called the communication assignment. This entailed reviewing an article from the *New England Journal of Medicine* entitled "Colonoscopic screening of average-risk women for colorectal neoplasia" (17), which was selected because of its recency and relevance to the course. The task requirements are shown in Table 1.

The communication assignment submissions (8% of the total course) were marked by the authors using a criteria-based assessment rubric (Table 2), which afforded specific feedback according to three criteria: 1) content (the key facts and concepts being determined by faculty members before the assignment was graded), 2) genre requirements, and 3) quality of writing. The criteria of content and genre requirements were constructed to match the three guide questions in the Introduction above.

*The explicit teaching intervention.* The explicit teaching of writing stages includes 1) defining the content or subject matter of interest, 2) analyzing models of writing around this content, 3) instructing students about relevant grammar and conventions of writing, and 4) constructing appropriate criteria to assess student writing (11). In this study, the intervention entailed three elements, which were delivered sequentially. First, an introductory lecture provided the rationale, significance, and importance of the Op-Ed task for enhancing the learning of course content and writing skills. A subsequent interactive lecture was delivered by a professional journalist from the School of Journalism and Communication. This lecture detailed the rhetorical purpose, text structure, and writing style of the Op-Ed genre. Specific points were that the Op-Ed 1) is a short text aiming to inform readers of recent scientific advances; 2) represents a formulaic

Table 1. Description of the communication assignment

Assessment weighting: 8%
Background
Effective communication of scientific facts is essential to increase the public's awareness of science and scientific discoveries. Writing a summary of a recently published journal article for a nonprofessional person will develop your understanding of current research into the area of physiology and pharmacology associated with diseases as well as improve your written communication skills.
Task instructions
The journal article you will write about is Schoenfeld et al. Colonoscopic screening of average-risk women for colorectal neoplasia. <i>N Engl J Med</i> 352: 2061–2068, 2005 (this is available on the BIOM3006 website).
Your assignment will be separated into three sections (introduction, body of text, and conclusions; these headings can be modified). Your assignment must have your name and student number clearly visible at the top of your assignment and a word count on a title page. The essay will be a total of 400 words ( $\pm 10\%$ ). The essay will be typed, 12-pt font, with double line spacing.
The following questions should be taken into consideration when you write the essay:
1. What is the basic knowledge in this area of science?
2. What are the key new facts/ideas that are described in this article?
3. Why was the work done?
4. What useful information will be important for the lives of the readers?
Refer to the assessment rubric as a guide.

Table 2. Assessment rubric used to grade the communication assignment

	Grades				
	8%	7–6%	5–4%	3–2%	1%
Content	<ul style="list-style-type: none"> <li>• Sufficient background is provided to enable very clear understanding of key ideas.</li> <li>• Key ideas are plausible and innovative.</li> </ul>	<ul style="list-style-type: none"> <li>• Background is provided to enable clear understanding of key ideas.</li> </ul>	<ul style="list-style-type: none"> <li>• Key facts and ideas of the article are stated.</li> </ul>	<ul style="list-style-type: none"> <li>• Key facts and ideas of the article are stated.</li> </ul>	<ul style="list-style-type: none"> <li>• Key facts and ideas of the article are not stated.</li> </ul>
Genre requirements	<ul style="list-style-type: none"> <li>• The description flows in a very cohesive and logical manner.</li> <li>• The description very clearly addresses the needs of the intended audience.</li> <li>• The description is consistent throughout.</li> </ul>	<ul style="list-style-type: none"> <li>• The description is cohesive and logical.</li> <li>• The description clearly addresses the needs of the intended audience.</li> <li>• The description is consistent throughout.</li> </ul>	<ul style="list-style-type: none"> <li>• The description is mostly cohesive and logical.</li> <li>• The description generally addresses the needs of the intended audience.</li> <li>• The description is consistent throughout.</li> </ul>	<ul style="list-style-type: none"> <li>• The description is mostly logical and generally addresses the needs of the intended audience, but it is not consistent throughout.</li> </ul>	<ul style="list-style-type: none"> <li>• The description lacks cohesion and/or logic.</li> <li>• The description poorly addresses the needs of the intended audience.</li> <li>• The description is not consistent throughout.</li> </ul>
Quality of writing	<ul style="list-style-type: none"> <li>• Key facts and ideas of the article are very clearly stated.</li> <li>• Grammar, syntax, and spelling are of a publishable (professional) standard throughout.</li> </ul>	<ul style="list-style-type: none"> <li>• Key facts and ideas of the article are clearly stated.</li> <li>• Grammar, syntax, and spelling are of a high standard.</li> </ul>	<ul style="list-style-type: none"> <li>• Some background is provided to enable understanding of key ideas, but details are lacking.</li> <li>• Grammar, syntax, and spelling are of a satisfactory standard.</li> </ul>	<ul style="list-style-type: none"> <li>• Background is insufficient to enable understanding of key ideas.</li> <li>• Grammar, syntax, and spelling are of a poor standard.</li> </ul>	<ul style="list-style-type: none"> <li>• Background is insufficient to enable clear understanding of key ideas.</li> <li>• Grammar, syntax, and spelling are of an unacceptable standard.</li> </ul>

Effective communication of the communication assignment (*assignment 1*) was graded as 8% (total). Descriptors are of the top standard for each criterion, and 0.5 grades were allowed (i.e., 7.5%). Nonsubmission was marked as 0%.

written genre broadly based on evoking readers' attention, interest, desire, conviction, and action (8); 3) uses an "inverted pyramid" structure in which the *who*, *what*, *when*, *why*, and *how* aspects of content are presented in the first paragraph; and 4) is written in an engaging plain English style targeting an audience with a reading age of ~12 yr. Students were taught to use and interpret "readability" algorithms using Microsoft Word, specifically, Flesch Reading Ease (FRE) scale (19). The FRE scale is a 100-point scale (with 0 = very hard and 100 = easy) with plain English being 63.5. Students were informed that these "readability" measures refer to the ease of understanding determined by surface text features that influence readers' decoding of texts rather than the complex cognitive process of comprehension (10, 19). Second, students were given access to professional Op-Ed pieces published in Australian newspapers (*The Australian* and *The Courier Mail*). Finally, as a means to explicating the task requirements, the assessment rubric for the Op-Ed was explicitly taught to students.

**The Op-Ed assignment.** Following the explicit teaching phase, students individually wrote an Op-Ed (400 ± 10% words) drawn from a *New England Journal of Medicine* article entitled "Combination of isosorbide dinitrate and hydralazine in African-Americans with heart failure" (20). The task is described in Table 3. The subject matter of this second article was also relevant to the course and (being from the same journal) complied with the same editorial guidelines. When the trigger articles for the communication and Op-Ed assignments were calculated using Word, the FRE scores were 8.9 and 14.4, respectively. Both of these scores are well below the definition of plain English, and thus both texts were complex to decode. The triggers were also very similar in word length, percentage of passive voice, and paragraph, sentence, and word length. The Op-Ed (12% of total course) was marked by one of the authors using the rubric (Table 4). The criteria were the same as, and the description of grades very similar to, the communication assignment. The minor difference in the description of grades reflected differences in the requirements of the two written assignments.

### Research Methods

**Analysis of students' writing.** Improvement in student writing was defined principally by an increase in grades (expressed as a percentage) for each assignment. The mean grades for the communication and Op-Ed assignments were compared using a paired *t*-test. This served as a measure of the inferred treatment effect due to explicit teaching.

A second measure of improved writing was a decrease in the FRE score, with the FRE score being a global index of the surface complexity of texts. Students were asked to submit their communication and Op-Ed assignments electronically for surface text analysis. These were all analyzed using the Microsoft Word readability algorithm to measure the FRE score, the percentage of text written in the passive voice, and the number of paragraphs, sentences per paragraph, words per sentence, and characters per word. Because the individual metrics (percent passive voice and paragraph, sentence, and word complexity) contribute to the FRE score, an improvement of writing would also be reflected in a decrease in some or all of these metrics. Descriptive statistics (means, SDs) were used to compare Op-Eds written by BIOM3006 students with those written by professional journalists. For the latter, 20 articles on current issues in the biomedical sciences were selected from two broadsheet newspapers: *The Australian* and *The Courier Mail*.

**Student opinion surveys.** An opinion survey was administered to students after they completed the Op-Ed assignment but before grades were returned. It consisted of seven closed items and the following question: "When completing the Op-Ed, what assistance was the *most* useful?"

Poorly designed surveys can be unreliable research instruments because they are prone to patterns of uncritical responses from disengaged respondents who might answer with identical responses for all items. The authors decided that such responses should be rejected from the survey data. To detect these responses and thus

Table 3. Description of the Opinion Editorial

Assessment weighting: 12%

Background

Effective communication of scientific facts is essential to increase the public’s awareness of science and scientific discoveries. Writing an Opinion Editorial of a recently published journal article for a nonprofessional person will develop your understanding of current research into the area of physiology and pharmacology associated with diseases. It will also introduce you to a form of communication of scientific facts in the media as well as improve your written communication skills.

Task instructions

The journal article you will write about is Taylor et al. Combination of isosorbide dinitrate and hydralazine in Blacks with heart failure. *N Engl J Med* 351: 2049–2057, 2004 (this is available on the BIOM3006 website).

Students will write their assignment in the format of an Opinion Editorial (see John Harrison’s lecture). Your assignment must have your name and student number clearly visible at the top of your assignment and a word count on a title page. The Opinion Editorial will have a 400 word ( $\pm 10\%$ ) length. The essay will be typed, 12-pt font, with double line spacing. Do not use columns.

The following key attributes need to be obvious in your assignment:

1. Title. Does it engage your audience?
2. Your language must be clear and comprehensible. Perform a Flesch reading ease test.
3. Do not use passive sentences. Active voice is used when the focus is on the action, e.g., active: Rita writes a letter; passive: a letter was written by Rita.
4. No references, figures, or tables are required. If these are included, they will not be marked.
5. You must express your opinion about this research and the findings. This must be your own opinion.

Refer to the assessment rubric as a guide.

improve the validity of the survey, closed items included a mix of questions worded affirmatively or negatively.

Students responded to the closed items on a Likert rating scale from 1 to 6, where 1 = very strongly disagree, 2 = strongly disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree, and 6 = very strongly agree. Descriptive statistics for each item of the survey data included only medians  $\pm$  interquartile

ranges. The nonparametric Wilcoxon signed-rank test was used to estimate whether the survey data median scores were different from 3 on the scale (i.e., neither agree nor disagree). Statistical significance was represented by *P* values, which were calculated using GraphPad Prism version 4. The internal consistency of all survey items was measured using Cronbach’s  $\alpha$ -coefficient using SPSS version 10.0 (Macintosh).  $\alpha$ -Values normally range from 0 to

Table 4. Assessment rubric used to grade the Opinion Editorial

	Grades				
	12–10%	9–7%	6–5%	4–3%	2–1%
Content	<ul style="list-style-type: none"> <li>● Key facts and ideas of the article are very clearly stated.</li> <li>● Sufficient background is provided to enable very clear understanding of key ideas.</li> <li>● Key ideas are plausible and innovative.</li> </ul>	<ul style="list-style-type: none"> <li>● Key facts and ideas of the article are clearly stated.</li> <li>● Background is provided to enable clear understanding of key ideas.</li> </ul>	<ul style="list-style-type: none"> <li>● Key facts and ideas of the article are stated.</li> <li>● Some background is provided to enable understanding of key ideas, but details are lacking.</li> </ul>	<ul style="list-style-type: none"> <li>● Key facts and ideas of the article are stated.</li> <li>● Background is insufficient to enable understanding of key ideas.</li> </ul>	<ul style="list-style-type: none"> <li>● Key facts and ideas of the article are not stated.</li> <li>● Background is insufficient to enable clear understanding of key ideas.</li> </ul>
Genre requirements	<ul style="list-style-type: none"> <li>● The argument flows in a very cohesive and logical manner.</li> <li>● The argument conforms very well to the structure and length of an Opinion Editorial.</li> <li>● The argument very clearly addresses the needs of the intended audience.</li> <li>● The argument is consistent throughout.</li> </ul>	<ul style="list-style-type: none"> <li>● The argument is cohesive and logical throughout.</li> <li>● The argument conforms well to the structure and length of an Opinion Editorial.</li> <li>● The argument clearly addresses the needs of the intended audience.</li> <li>● The argument is consistent throughout.</li> </ul>	<ul style="list-style-type: none"> <li>● The argument is mostly cohesive and logical.</li> <li>● The argument conforms adequately to the structure and length of an Opinion Editorial.</li> <li>● The argument generally addresses the needs of the intended audience.</li> <li>● The argument is consistent throughout.</li> </ul>	<ul style="list-style-type: none"> <li>● The argument is mostly logical.</li> <li>● The argument conforms poorly to the structure and length of an Opinion Editorial.</li> <li>● The argument generally addresses the needs of the intended audience, but it is not consistent throughout.</li> </ul>	<ul style="list-style-type: none"> <li>● The argument lacks cohesion and/or logic.</li> <li>● The argument conforms very poorly to the structure and length of an Opinion Editorial.</li> <li>● The argument poorly addresses the needs of the intended audience.</li> <li>● The argument is not consistent throughout.</li> </ul>
Quality of writing	<ul style="list-style-type: none"> <li>● Grammar, syntax, and spelling are of a publishable (professional) standard throughout.</li> </ul>	<ul style="list-style-type: none"> <li>● Grammar, syntax, and spelling are of a high standard.</li> </ul>	<ul style="list-style-type: none"> <li>● Grammar, syntax, and spelling are of a satisfactory standard.</li> </ul>	<ul style="list-style-type: none"> <li>● Grammar, syntax, and spelling are of a poor standard.</li> </ul>	<ul style="list-style-type: none"> <li>● Grammar, syntax, and spelling are of an unacceptable standard.</li> </ul>

Effective communication of the Opinion Editorial assignment (*assignment 2*) was graded as 12% (total). Descriptors are of the top standard for each criterion, and 0.5 grades were allowed (i.e., 7.5%). Nonsubmission was marked as 0%.



1, with  $\alpha$  of 0.8 or higher indicating that survey items reliably measure related themes or constructs on which the survey questions are based. Students were informed about the purposes of the opinion survey and advised that their participation was voluntary and anonymous, that they could withdraw from the study at any time, and that their decision would not affect grades for the course. These details were also written on the front of the survey instrument.

*Opinion survey for the public.* A communication assignment (Table 5) and an Op-Ed assignment (Table 6) were both selected from one student who had shown a large improvement in their writing, being 56% and 90%, respectively. The FRE index and metrics of these examples were typical of assignments from the whole cohort. With the student author's permission and all identifying cues removed, the communication and Op-Ed assignments were presented as examples of student writing along with surveys administered to members of the public, many of whom lived near the university. Surveys included demographic information (gender, age group, current employment, and highest educational qualification), the question "What is your *main* source of information about new scientific findings?," and a set of 10 closed survey items about both the communication and Op-Ed assignment examples. These surveys included instructions to respondents, a request for the consent of respondents, and the following orientation: "In the School of Biomedical Sciences (The University of Queensland), we teach students how to improve their writing. As an assignment, final-year Science students were asked to write two short articles on recent findings in biomedical research. You have been given two articles written by the same student. These articles are aimed at readers who are *not* biomedical scientists. Your opinions about each article will help us teach more effectively. In turn, this will help our students communicate more effectively with diverse groups of people."

Respondents were also asked the following questions: "Which article (Communication Assignment or Op-Ed) was easier to read?" and "What made this article easier to read?"

## RESULTS

### *Student Achievements for the Communication and Op-Ed Assignments*

Grades were expressed as a percentage of the maximum grade for each assignment. For the communication assignment, the mean score (SD) was 74.7% (11.9%) ( $n = 218$ ). Grades for the Op-Ed assignment had a mean score (SD) of 84.4% (9.1%) ( $n = 216$ ). Although all students increased their raw scores from their communication to Op-Ed assignment, 57 students (26%) did not improve the percentage of maximum grades. This included 10 students receiving the same result and 47 students with a reduced grade. However, for students in the latter group, all but two students received grades of over 75% for their communication assignment and, therefore, were already competent writers.

### *Text Analysis of the Communication and Op-Ed Assignments*

Most students submitted their assignments for surface text analysis using Word readability statistics (communication assignment:  $n = 196$ , 90% of students; Op-Ed assignment:  $n = 210$ , 96% of students). The means and SDs of readability indexes and metrics for the students' communication and Op-Ed assignments and for 20 professional Op-Eds are shown in Table 7. For the FRE index and all metrics, students' communication and Op-Ed assignments were very significantly different ( $P < 0.0001$ ), with all measures reflecting a relative decrease in the textual complexity of the Op-Eds. As determined by the FRE scores, most of the students' Op-Eds were as easy to decode as those written by professional journalists. Student and professional Op-Eds were significantly different in the number of passive sentences, sentences per paragraph, and words per sentence.

Table 5. *Example communication assignment presented to members of the lay public*

#### *Colonoscopy and Flexible Sigmoidoscopy: Their Effectiveness in Diagnosing Colorectal Neoplasia in Women*

##### Introduction

Colonoscopy and flexible sigmoidoscopy are useful in detecting colorectal neoplasia (growths (cancer included) in the large intestine) in people who are asymptomatic (showing no overt clinical symptoms of disease). Studies have already been done into the diagnostic yield of colonoscopy and flexible sigmoidoscopy with regard to men. The yield of either of these diagnosis methods is still unknown in women.

Colonoscopy is the preferred method of diagnosing neoplasia in the colon as it can reach the entirety of the large intestine. On the other hand flexible sigmoidoscopy at best can only reach the splenic flexure in a majority of cases however it will only reach the junction between the sigmoid and descending colons. Flexible sigmoidoscopy is also cheaper and has been thought due to its reduced cost it might be useful in diagnosis of low risk patients of less than 60 years.

##### Method

Women enrolled in the study were between 40 and 79 years of age, the majority were over 50 years old. As this study was of asymptomatic women, anyone who showed signs of having colorectal neoplasia were refused entry.

Gastroenterologists or colorectal surgeons performed colonoscopies and flexible sigmoidoscopies in 99% of all cases studied. Any polyps that were then found had their location taken, size measured and a polypectomy (a procedure that allows a polyp to be cleanly excised endoscopically) was then performed.

##### Results

This study had 1483 women participate in it. Of those 1483, 1463 had a colonoscopy to the end of the caecum (the most proximal point in the large intestine from the rectum). Of these 1463, 20.4% (299 women) had polyps in their large intestine. 72 women (4.9%) had advanced colorectal neoplasia and another 227 (15.5%) women had small or non-advanced lesions. Advanced neoplasia was found in 3.3% of women aged 50–59 years, 5.5% of women aged 60–69 years and 11.7% of women aged 70–79 years.

The diagnostic yield when only flexible sigmoidoscopy is used 34.7%, as the rest had neoplasia further up the large intestine, which would have not been found.

When the distal colon was only the rectum and the sigmoid colon advanced neoplasia was found in only 1.7% and missed in 3.2% of all women. When the descending colon was added to that definition then 2.2% was found and 2.7% were missed.

##### Discussion

As has been said earlier, flexible sigmoidoscopy is cheaper to perform than a colonoscopy. That being said it still does not totally inspect the entirety of the large intestine, which can be dangerous as age moves on. Due to its small diagnostic yield it has been deliberated that Colonoscopy is still the preferred method of diagnosis for colorectal neoplasia.

Table 6. Example Opinion Editorial presented to members of the lay public

*DRUG THERAPY: Deaths stop heart study*

Scientists stopped a study of combination drug therapy on African-American heart failure patients due to the significantly higher death rate of patients receiving a placebo.  
 The study involved 1050 African-American patients with advanced heart failure.  
 Fifty-four patients or around 10 percent of the group receiving a placebo died during the study.  
 Only 32 patients or six percent of those receiving the combination therapy died.  
 African-American patients with advanced heart failure received the combination therapy of a fixed dose of isosorbide dinitrate and hydralazine.  
 Scientists said this group had shown a favourable response to this type of therapy in the past.  
 Previous studies suggested that African-Americans in comparison to white Americans have a less active salt regulation system leading to greater water retention. African-American Americans' also have a decreased availability of nitric oxide.  
 Both of these factors decrease the body's ability to deal with high blood pressure and decreasing high blood pressure is paramount in dealing with heart failure.  
 This combination drug therapy combats these two factors and is therefore more effective for African-American people with heart failure.  
 The study was a double blind trial with both groups receiving standard drug therapy for heart failure while one group received a placebo and the other group received the combination therapy.  
 The success of the study was gauged on three factors-death from any cause, first hospitalization for heart failure and a change in the quality of life.  
 Despite the high death rate of patients in the placebo group, the study was considered successful as it did show that the combination therapy gave a 43 percent increase in survival rates; 33 percent reduction in the rate of first hospitalization for heart failure and an improvement in the quality of life for the patients.  
 Scientists involved in the study defended their actions noting that all the patients in the study suffered from advanced heart failure and there were deaths in both groups.  
 Scientists noted that all patients entering the study did so voluntarily with a full understanding of what the study involved.  
 They also noted that this study was unique in that it specifically investigated African-Americans, their biological differences and their reaction to these drugs.  
 This is a shift away from normal drug therapy design, which normally targets biological responses over the entire mixed population.

This article was written by the same student as the communication assignment shown in Table 5.

*Student Opinion Survey*

One hundred and forty-two student opinion surveys (63%) were returned. Only one return was deemed invalid because all responses were marked as "3." The Cronbach's  $\alpha$ -coefficient of the total seven-item survey was 0.9847, indicating very high reliability of survey items in measuring related themes.

Student responses from closed survey questions are shown in Fig. 2. Most students reported they understood the usefulness of more effectively communicating science to lay audiences (median = 4,  $P < 0.0001$ ). However, as a cohort, there was neither agreement for nor against the notion that writing the communication and Op-Ed assignments was useful for their careers (median = 3,  $P = 0.1522$ ). Writing these tasks helped the majority of students realize the difficulty in writing to nonprofessional readers (median = 4,  $P < 0.0001$ ). Although most students understood the requirements of the assignments (median = 2.5,  $P = 0.0140$ ), these tasks were challenging (median = 4,  $P < 0.0001$ ). While most students reported that the communication and Op-Ed assignments were valuable learning experiences (median = 4,  $P = 0.0003$ ), most students

neither agreed nor disagreed that their writing had improved (median = 3,  $P = 0.0005$ ). This apparent uncertainty may have been influenced by the fact that they had not yet received grades and feedback for their Op-Eds.

*Opinion Survey of the Public*

Seventy-eight surveys (35%) were returned. The demographic information from the sample population was compared with the most recently available census figures (2001) from the state of Queensland (1) (Table 8). Males were underrepresented in the survey. The age distribution of respondents closely reflected the state figures, with 22% of the survey sample (vs. 26% for the state) represented in each 10-yr interval from 21 to 60 yr of age, i.e., 21–30, 31–40, 41–50, and 51–60 yr of age. The completion rate of high school education was also similar (68% in the sample and 72% in the state), as was the proportion of respondents possessing postsecondary qualifications (33% in the sample and 32% in the state). However, survey respondents had more formal education than most people in the state, with diplomas and bachelor degrees

Table 7. Surface text analyses of student communication assignments, student Opinion Editorials, and Opinion Editorials written by professional journalists

Writing	Numbers of Articles	FRE, mean (SD)	Words, mean (SD)	%Passive Voice, mean (SD)	Numbers of Sentences/Paragraph, mean (SD)	Numbers of Words/Sentences, mean (SD)	Numbers of Characters/Word, mean (SD)
Student communication assignment	196	19.3 (8.7)	445.9 (46.6)	33.3 (14.9)	3.8 (1.4)	24.0 (4.3)	5.3 (0.24)
Student Opinion Editorial	210	38.9 (9.3)	426.5 (27.1)	9.5 (12.8)*	2.7 (1.3)*	20.1 (5.1)*	5.1 (0.3)
Professional Opinion Editorial	20	38.7 (7.2)	408.0 (10.3)	0 (0)*	1.4 (0.2)*	24.7 (3.2)*	5.0 (0.2)

FRE, Flesch reading ease scale, which ranged from 0 points (most difficult text) to 100 points (easiest text). The numbers of sentences/paragraph represent paragraph complexity; the numbers of words/sentences represent sentence complexity; and the numbers of characters/word represent word complexity. \*Mean values are significantly different ( $P < 0.05$ ). Mean values for the FRE and all metrics are very different for students' communication and Opinion Editorial,  $P < 0.0001$ .

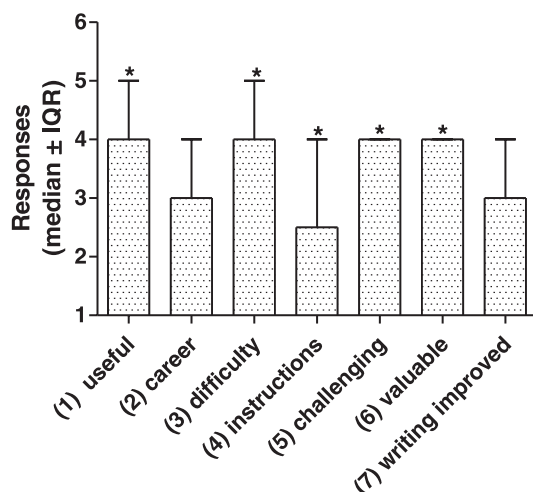


Fig. 2. Student responses [median  $\pm$  interquartile ranges (IQR)] to items of the following opinion survey: 1. I understood the usefulness of these tasks. 2. I did NOT think that completing these tasks was useful for my future career. 3. These tasks helped me realize the difficulty in writing to a nonprofessional person. 4. I did not understand the instructions of both tasks. 5. I found these exercises challenging. 6. These tasks provided me with a valuable learning experience. 7. After completing the CA and Op-Ed assignment, I believe that my writing has improved. \* $P < 0.05$  ( $n = 142$ ) based on the difference in median values from the scale point of 3 (neither disagree nor agree) using the nonparametric Wilcoxon signed-rank test.

being more represented. This likely reflects the university locale in which the study was conducted. Seventy-nine percent of respondents reported their occupations. These included administrative (24%), retired (21%), home duties (10%), business (8%), and nonscience students (8%), with the rest from another 14 occupations. Fifty-three percent of respondents indicated that their main source of scientific knowledge was television, and 28% of respondents indicated newspapers. Other sources included the internet, "journals," family, doctor, radio, and magazines.

The survey data are summarized in Fig. 3. The Cronbach's  $\alpha$ -coefficients of the total 10-item surveys were 0.9883 and 0.9831 for the communication and Op-Ed assignments, respectively. These indicated very high reliability in measuring related themes. For both the communication and Op-Ed assignments, respondents reported that the author tried to improve their knowledge of the areas of research represented in both articles ( $P < 0.0001$ ) and that the information in the texts was

Table 8. Comparison of demographic data from survey respondents compared with 2001 census figures from the state of Queensland

Attribute	Survey Sample, %	Queensland 2001 Census Figures, %
Male	36	49.7
Female	64	50.3
Distribution of age groups, mean (SD)	22 (2)	26 (2)
Completed high school	68	72
Possess a qualification	33	32
Certificate	8	49
Diploma	31	17
Bachelor degree	58	26
Graduate degree	4	8

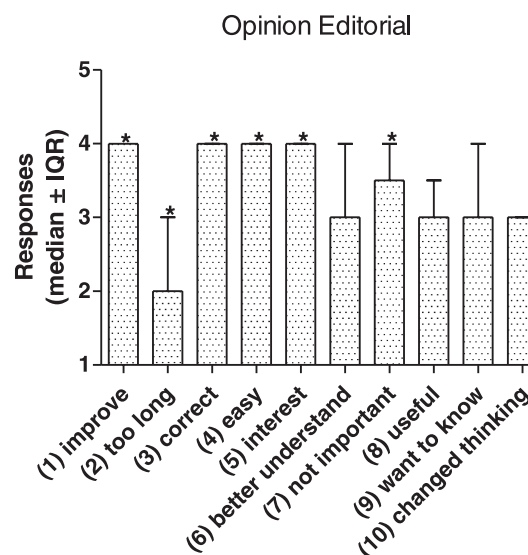
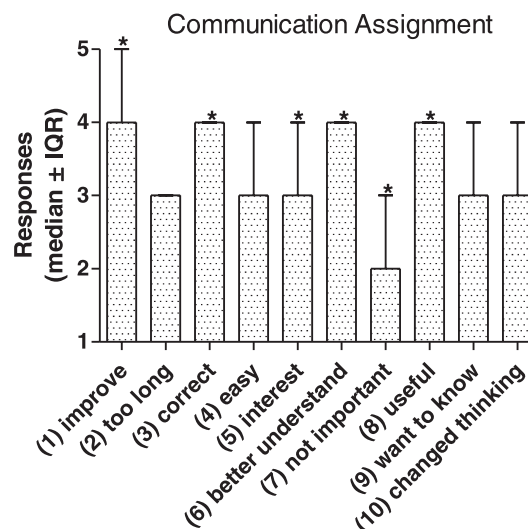


Fig. 3. Lay public responses (medians  $\pm$  IQR) to items of the following opinion survey for both the CA and Op-Ed: 1. The author tried to improve my knowledge of this area of research. 2. The article was too long. 3. I believe the information in the article was correct. 4. The article was easy to understand. 5. My interest level was sustained throughout the article. 6. After reading the article, I now have a better understanding of colonoscopy (CA) or drug therapy (Op-Ed). 7. This information about colonoscopy (CA) or drug therapy (Op-Ed) is not important to me. 8. This information about colonoscopy (CA) or drug therapy (Op-Ed) is useful to me. 9. This article made me want to know about future developments in this area. 10. Reading this article has changed the way I think about my health. \* $P < 0.05$  ( $n = 78$ ) based on the difference in median values from the scale point of 3 (neither disagree nor agree) using the nonparametric Wilcoxon signed-rank test.

correct ( $P < 0.0001$ ). The Op-Ed was favored over the communication assignment in three items. It was 1) easier to understand, 2) better sustained interest throughout the article, and 3) perceived to change the way the reader thought about their own health, although this effect was statistically weak ( $P = 0.0150$ ). In responding to the two open questions, 65% believed that the Op-Ed was easier to read than the communication assignment. Of these, 35 respondents reported that the Op-Ed used less scientific and medical terminology; had fewer



statistics, thus making it easier to read; and that the structure (“shorter sentences,” “more direct/concise,” and “layout”) made it easier to read.

However, the content matter of the communication assignment (i.e., bowel cancer) was considered to be more important and useful than the content of the Op-Ed (i.e., drug therapy). Thus, the significance of the content matter to the readers outweighed the importance of text structure and surface features. Nevertheless, those respondents who reported that the Op-Ed was easier to read justified their decision based on structural elements of text rather than the content.

## DISCUSSION

The study reported here was the second phase of an action learning project based around three research questions.

### *Question 1. Does Explicit Teaching Improve the Ability of Students to Write Effectively to a Lay Audience?*

In this study, explicit teaching included three elements: instructing physiology and pharmacology students as to how to write Op-Eds, analyzing examples of Op-Eds written by professionals, and discussing the assessment rubric with students to make the grading process transparent. Prior to the explicit teaching, most students were already able to write effectively to lay audiences, reflected by the high grades for their communication assignment [mean (SD) = 74.7% (11.9%),  $n = 218$ ]. This result was similar to the grades for the Op-Eds [mean (SD) = 74.0% (1.6%),  $n = 232$ ] recorded in the first phase of the study, in which there was no pretest measure (14). It is worth noting that there was little evidence for the frequent claim from faculty members that “students can’t write.” In the present study, following explicit teaching, most students were able to write more effectively, with the results for the Op-Eds being significantly higher [mean (SD) = 84.4% (9.1%),  $n = 216$ ]. Only some of the already very capable writers did not improve. This improvement in writing was associated with the explicit teaching intervention. It might be argued that this reflects the “practice effect” of writing (assessed by the same criteria). On that basis, it would be expected that most students would improve their results. However, while the communication and Op-Ed assignments share the same general communication purpose, they had distinctly different genre requirements. Most notably, the communication assignment had a relatively unstructured format based around guide questions, whereas the Op-Ed addressed these same issues using a structured format of brief paragraphs and a more focused and refined rhetorical purpose. The students were not told that they were to write an Op-Ed before the explicit teaching, so they could not practice writing Op-Eds. In addition, the improvement in students’ writing was supported by a decrease in text complexity following explicit teaching (Table 7). The global FRE index as well as all recorded metrics of text complexity indicated that the Op-Eds were more appropriate than the communication assignment for lay readers. Similar to the first phase of this study (14), most students were able to reproduce the text characteristics of professionally written Op-Eds. Students reported that the examples of Op-Eds written by professional journalists greatly assisted their writing. In the present study, examples were used in combination with the assessment

rubric and thus served to make the abstract criteria more concrete and practical.

### *Question 2. What Do Students Think About Learning to Write to Lay Audiences?*

Responses from students to completing the Op-Ed were largely positive. Learning to communicate more effectively to lay audiences was considered useful and relevant to their careers as was the specific task of writing an Op-Ed. These data support the proposition that students who are provided with evidence for the role of professional writing are less opposed to learning writing skills (21).

Most students reported that writing the Op-Ed helped them realize the difficulty in writing to lay audiences and that writing the communication and Op-Ed assignments was challenging. However, there were differences in the posttask opinions of students from the 2004 (first) phase and the 2005 (second) phase. The report of “difficulty” was 87% versus 71% and of “challenge” was 80% versus 55% for the 2004 and 2005 cohorts, respectively. Again, this reduction in perceived difficulty and challenge was associated with the introduction of explicit teaching, which strongly supported the development of relevant writing skills and aimed at reducing the perceived difficulty in writing. Many students reported (before grades were returned) that their writing had improved, further supporting the efficacy of explicit teaching.

### *Question 3. Can Members of the Lay Public Recognize Differences in the Quality of Students’ Writing Before and After Explicit Teaching?*

Assessment tasks in science are more useful if they are authentic (2). In this study, the audience for the assignments was a small sample of the public who were not experts in physiology or pharmacology. It was not practical to distribute all student assignments because of the large class size. However, the opinions of the lay public regarding the writing of one student were surveyed. The sample communication and Op-Ed assignments from this student were selected because faculty members had determined a large improvement in the student’s writing and wanted to know if the intended audience agreed. We predicted that the lay public would agree because the academic criteria were designed to reflect the relevant genre requirements. This prediction was borne out. Most respondents reported that the Op-Ed was favored over the communication assignment because it was easier to read and understand and used more simple language and text structure. The latter claim was supported by FRE and text metrics. That many respondents reported the communication assignment was more important and useful reflected their interest in the subject matter and not the structure of the text or more general features of writing. Readers’ interests, prior knowledge, and needs are equally important variables in comprehension (19) and, furthermore, play an important role in influencing the development of scientific literacy (16).

This sample was broadly representative of the state population for age distribution, high school completion rate, and qualifications. However, compared with the 2001 state census figures, the sample vastly overrepresented females and levels of formal education. Detailed statistical design was beyond the scope of this small-scale study. Nevertheless, survey respon-

dents were correctly categorized as “lay,” i.e., nonexpert in physiology or pharmacology (3).

### Future Directions

The need for science professionals to more effectively communicate their expertise to the lay public is widely recognized, but *how* this goal might be achieved is a significant problem in undergraduate degree programs. The media role model was developed to describe how students can learn to more effectively communicate science to lay audiences (14). In this second phase of research, the model has proven useful to frame how faculty members can use explicit teaching as part of this professional developmental process.

It is important that students are able to develop a commitment to improving communication of science to the lay public and take this into their workplace. Sustaining this commitment is challenging (22). However, we contend that universities must play an important role in instilling this ethos in students by encouraging them to directly engage with the lay public around their emerging understandings of science. This will be explored in the next phase of this action learning study.

### ACKNOWLEDGMENTS

We thank Dr. John Harrison (School of Journalism, The University of Queensland) for the sustained support of this project and Assoc. Prof. Lesley Lluca for the useful feedback on this manuscript.

### REFERENCES

1. **Australian Bureau of Statistics.** 2001 Census Data (online). <http://www8.abs.gov.au/ABSNavigation/> [21 October 2006].
2. **Biggs J.** *Teaching for Quality Learning at University: What the Student Does* (2nd ed.). Suffolk, UK: The Society for Research into Higher Education and Open Univ. Press, 2003.
3. **Burns TW, O'Connor DJ, Stockmayer SM.** Science communication: a contemporary definition. *Public Understanding Sci* 12: 183–202, 2003.
4. **Bruno F, Vercellesi L.** Science information in the media: an academic approach to improve its intrinsic quality. *Pharmacol Res* 45: 51–55, 2002.
5. **Carter M, Ferzli M, Wiebe E.** Teaching genre to English first-language adults: a study of the laboratory report. *Res Teach Engl* 38: 395–419, 2004.
6. **Cribb J, Hartomo TS.** *Sharing Knowledge: a Guide to Effective Science Communication*. Collingwood, Victoria, Australia: CSIRO, 2002.
7. **Cook TD, Campbell DT.** *Quasi-Experimentation: Design and Analysis Issues for Field Settings*. Chicago, IL: Rand-McNally, 1979.
8. **Hyland K.** *Teaching and Researching Writing*. Harlow, UK: Pearson Education, 2002.
9. **Kember D.** *Action Learning and Action Research*. London: Kogan Page, 2000.
10. **Klare GR.** *The Measurement of Readability*. Ames, IA: Iowa State Univ. Press, 1963.
11. **Knapp P, Watkins M.** *Genre, Text, Grammar: Technologies for Teaching and Assessing Writing*. Sydney, Australia: Univ. of New South Wales, 2005.
12. **Kolb DA.** *Experiential Learning: Experience as the Source of Learning and Development*. Englewood Cliffs, NJ: Prentice Hall, 1984.
13. **Pechenik JA.** *A Short Guide to Writing About Biology* (5th ed.). New York: Pearson Longman, 2004.
14. **Poronnik P, Moni RW.** The Opinion Editorial: teaching physiology outside the box. *Adv Physiol Educ* 30: 73–82, 2006.
15. **Resnik DB.** Ethical dilemmas in communicating medical information to the public. *Health Policy* 55: 129–149, 2001.
16. **Roth WM, Barton AC.** *Rethinking Scientific Literacy*. New York: Routledge Falmer, 2005.
17. **Schoenfeld P, Cash B, Flood A, Dohan R, Eastone J, Coyle W, Kikendall JW, Kim HM, Weiss DG, Emory T, Schatzkin A, Lieberman D.** For the CONCeRN Study Investigators. Colonoscopic screening of average-risk women for colorectal neoplasia. *N Engl J Med* 35: 2061–2068, 2005.
18. **Shaw J.** Research into practice: learning by doing. In: *Enhancing Teaching in Higher Education*, edited by Hartley P, Woods A, Pill M. Abingdon, UK: Routledge, 2005, p. 147–154.
19. **Stephens C.** *Everything You Ever Wanted to Know About Readability Tests but Were Afraid to Ask*. <http://www.gopdg.com/plainlanguage/readability.html> [14 March 2007].
20. **Taylor AL, Ziesche S, Yancy C, Carson P, D'Agostino R, Ferdinand K, Taylor M, Adams K, Sabolinski M, Worcel M, Cohn N.** For the African-American Heart Failure Trial Investigators. Combination of isosorbide dinitrate and hydralazine in Blacks with heart failure. *N Engl J Med* 351: 2049–2057, 2004.
21. **Tilstra L.** Using journal articles to teach writing skills for laboratory reports in general chemistry. *J Chem Educ* 78: 762–764, 2001.
22. **Yore LD, Hand BM, Prain V.** Scientists as writers. *Sci Educ* 86: 672–692, 2002.