The Asian Journal of Applied Linguistics
Vol. 5 No. 1, 2018, pp. 4-18

AJAL

The appliance of science: The challenges of undergraduate science students writing popular science

Simon Boynton
The Centre for Applied English Studies, The University of Hong Kong

Popular science writing is rarely referred to in the literature yet could be used as a writing task for undergraduate science students. Since 2013-14, a popular science article writing task has been used as the main writing task in an English-in-the-Discipline course for second year undergraduate science students from multiple scientific disciplines at a university in Hong Kong. In this course students were formally taught the genre features of popular science articles and research articles using the concept of reader-writer proximity (Hyland, 2010) in which the fixed rhetorical features are used to "construct both the reader and writer as people with similar understandings and goals" (Hyland, 2010, p. 116). Samples of students' writing were analysed for genre features through Hyland's concept of proximity, and individual interviews conducted with their authors. The objectives of the study were to determine (1) to what extent students can incorporate and successfully use features of popular science in their writing, (2) what factors affect students' ability to incorporate and successfully use these features, and (3) the pedagogical implications for helping students to write successful popular science articles in future courses.

Keywords: popular science; undergraduate writing; English-in-the-Discipline; academic writing; undergraduate science; genre; Hong Kong

Introduction

This paper documents and discusses the introduction of a popular science writing component into an English-in-the-Discipline (ED) course in a university in Hong Kong. The course is a compulsory Year 2 course taken by all students in the Faculty of Science and is preceded by a Year 1 compulsory General English for Academic Purposes Course. ED courses are designed to be highly related to the students' disciplines and address areas of weakness or gaps in student knowledge/language skills which their parent departments have identified. The main focus of this ED course is its writing component, the course serves students from all 16 majors within the faculty which constitutes considerable variety (see Table 1).

Designing a writing component to cater for students from such diverse majors was challenging. It was important to retain a science theme and differentiate the course from the Year 1 General EAP course (which focuses on essay and report writing). The focus on a popular science article (PSA) was selected to encourage students to use their scientific knowledge from their own disciplines by repackaging it for a non-specialist audience.

Popular Science as a writing task for undergraduate students is rarely mentioned in the literature. The study reported explores whether it is an appropriate task and determines the extent to which students are able to successfully write a PSA. More specifically, this paper will focus on answering the following three questions:

ISSN 2308-6262
http://caes.hku.hk/ajal

1. To what extent are undergraduate science students able to incorporate genre features of popular science writing into their own PSA after receiving some instruction in this area?
2. Which factors affect students' ability to incorporate and successfully use the above genre features?
3. What are the pedagogical implications for helping students to write successful PSAs in future courses?

Table 1. Majors offered within the Science Faculty at the time of the study

• Astronomy
• Biochemistry
• Biological Sciences
• Chemistry
• Earth System Science
• Ecology & Biodiversity
• Environmental Science
• Food & Nutritional Science
• Geology
• Mathematics
• Mathematics/Physics
• Molecular Biology & Biotechnology
• Physics
• Risk Management
• Statistics

Literature review

Undergraduate science writing at university

The two main forms of science writing for science undergraduates are essays and lab-reports (Jackson, Meyer, & Parkinson, 2006; Parkinson, 2000). Lab reports are the most common (Braine, 1989; Jackson et al., 2006). Another form of science writing is mathematical proofs, and these have their own specific genre features. The course discussed in this paper does not deal with lab reports or mathematical proofs as these are formally or informally taught by disciplinary teachers. The writer of this paper was involved in the writing of a mathematical proofs style guide with a maths professor, and this is made available to maths students.

Perhaps the most widespread form in which science is communicated to the general public in the written form is the PSA, through popular science magazines such as *New Scientist* and *Scientific American* (Hyland, 2010), but many daily newspapers also have specialized science and technology sections and these are increasingly popular. A PSA, then, would seem to be a good fit for the course described here because it would retain the focus on science while being manageable with students from such a diverse spread of science majors. It would require disciplinary knowledge but not disciplinary specific scientific jargon or writing style.

Parkinson and Adendorff (2004) used PSAs in undergraduate courses in South Africa to develop their students' scientific literacy. They argued that popular science as a written genre was more accessible to students than research articles (RAs) which

make science seem authoritative and difficult to learn (Lemke, 1990). However, they cautioned against overexposure to popular science to prevent students modelling their academic writing on popular science texts (Parkinson & Adendorff, 2004). For the course described here this is not a problem because the goal is to show students how to write PSAs.

Features of popular science writing

According to Parkinson and Adendorff (2004) sensitizing students to the different registers of science writing and increasing their science literacy could be achieved by comparing academic scientific writing (textbooks and research articles) with popular science writing. They suggest that "it needs to be made explicit to students that there is a register difference, and what features of popular and academic science are" (p. 392). Lemke (1990) goes a step further, recommending that students can translate from formal science and use colloquial language.

Hyland's concept of proximity

Hyland (2010) conducted a comprehensive comparison of features of RAs and PSAs. The focus of his comparison revolves around how the writer constructs proximity to the reader which he defines as "a writer's control of rhetorical features which display both an authority as an expert and a personal position towards issues in an unfolding text" (p. 117).

There are two central ideas in this concept of constructing proximity. First, popular science writers and researchers use different writing features to achieve the same goals which are "textually constructing both the reader and writer as people with similar understandings and goals" (Hyland, 2010, p. 177). For the researcher, the goal is to provide a clear record of scientific procedures so that the research can be seen as valid and reproducible. For the popular science writer, the goal is aligned with newsworthiness qualities such as novelty (newness or originality), recency (the topic being recent) and relevance (van Dijk, 1988).

The second central idea in constructing proximity is that both kinds of writers write in ways which are most likely to meet the expectations of their readers. Both kinds of writers are experts who show their expertise in their delivery of scientific knowledge; the expertise of popular science writers is their ability to repackage complex scientific knowledge for a non-specialist audience.

Hyland (2010) identifies 12 ways in which academic and popular science writers achieve proximity for their respective audiences. For the course described here these were simplified into 9 features which were presented to the students in a genre features table after some activities which compare and contrast the genre features (see Appendix 1). The table demonstrates to students that the two kinds of writers use the same features to create proximity to the reader, but with different methods. For example, both introduce new information (Feature A in Appendix 1). However, in RAs it is introduced carefully, usually by identifying a gap in the current research area first (Hyland, 1996, 1998, 2010); in other words the novelty is played down. In contrast, novelty in PSAs is emphasized in order to engage the reader.

Popular science in the course

The main writing task on the course was a PSA for a "fake" online journal. Students were given help towards this goal in the form of formative tasks with teacher feedback

such as an annotated bibliography, a partial draft, in-class materials, and out-of-class materials.

The most goal-related in-class materials were a session comparing genre features of PSAs and RAs, and a session on metaphors and analogies in science writing. The most goal-related out-of-class materials were a summary of differences between PSAs and RAs, and a website with Grade A samples of PSAs from former students. Students were also encouraged to read PSAs outside the class. The session on genre features of PSAs and RAs is briefly described below.

The materials for teaching genre features of PSAs are based on those identified by Hyland (2010). Students were shown a number of extracts from PSAs and RAs which contained examples of each genre feature. Wherever possible, extracts from PSAs were used that were based on an RA of that particular topic.

Firstly, the students categorized the article extracts into either PSA or RA and then identified the features of the extracts which helped them decide. Secondly, the students completed a table identifying which kind of article the features belonged to. At the end of the lesson students were referred to a genre features table (Appendix 1) in which the features are compared and this served as an out-of-class reference.

Methodology

The data for this study consisted of individual interviews with 17 students and the final draft of their PSAs.

Final draft of the popular science article

The participants in this study consisted of 17 students who completed the course. Each of them provided a draft PSA and participated in an individual interview. The PSAs were analysed using the genre features comparison table from the in-class materials (Appendix 1). For coding purposes, three of these features (B, C, and D) were subdivided as shown in the Key to Table 3b.

The student interviews lasted around one hour each and were audio recorded. The interviews were semi-structures, starting with a common set of questions (Appendix 2) and the use of follow up questions as needed.

The questions focused on: student's opinion of the writing task (Q1); the process of selecting their PSA topic (Q2); sources students used for writing their PSAs (Q 3-5); the utility of in-class materials (Q6); the PSA genre features they had used (Q 7-9); and suggestions for the writing task (Q10). To facilitate students' recall the interviews were conducted in a relaxed atmosphere and reminders provided where relevant, for example the in-class materials were shown to them and the final draft of their PSA was brought to the meeting.

Data analysis

The PSA texts were coded for every instance of genre features using the genre features adapted from Hyland (2010) and used in the in-class materials (Appendix 1). The use of a feature was considered successful if it created proximity to the reader using Hyland's definition.

After an initial analysis of all PSAs, problematic instances of genre features were listed, and a second round of analysis identified and grouped all instances of common problems. Each genre feature in each PSA was then allocated a numerical value representing the degree to which that feature had been used successfully within the PSA (see Table 2 for the criteria and values assigned). All the features were equally weighted

as all help to create proximity to the reader. This numerical data allowed the calculation of an overall value representing the successful use of genre features for each PSA. Student interview responses were analysed in relation to the PSA features.

Table 2. Coding of overall use of individual genre features

Value assigned	Degree of success	Criteria
4	Successful	More than half the instances of a genre feature are used successfully.
2	Partially Successful	Around half the instances of a genre feature are used successfully. The other half of the instances are problematic.
1	Unsuccessful	More than half the instances of a genre feature are problematic
0	Not used	This feature was not used by the student

Results and discussion

This section addresses the three research questions.

Research question 1: Which features were incorporated and how successfully

Looking at the data ranked according to the successful use of genre features (Table 3a) or ranked according to overall success of individual students (Table 3b) reveals important points about the successful and less successful use of features.

Successful features

Features B1, D2, G and E were attempted by all students and the majority of students used these successfully or with partial success. B1 (emphasizing the results of the research) and D2 (techniques to help the reader) with new knowledge both relate to explaining the science. G (using “we”/”our”/”us”) shows the writer reaching out and engaging with the reader. E (attitude of writer) is related to stance, which students were familiar with because it had been covered in the Year 1 course.

Features used with mixed success

Features B2, C1 and I, were attempted by most students but with mixed success. B2 involves explaining the science of the topic, and over half of the students managed to do this successfully. Two students (S14 and S15) did not explain any science at all, three students (S1, S7 and S11) encountered major difficulties, and one student (S2) was partially successful. All students included research (C1) but only around half of the students managed to successfully refer to the researchers. Feature I (use of questions) was only performed successfully by half of students. Most students included questions, but half of those that did experienced problems.

Table 3a: Total score of genre features organized by genre feature

Genre Feature Code	Students																	Genre feature total
	S6	S13	S10	S5	S4	S8	S3	S1	S17	S12	S2	S15	S9	S14	S16	S11	S7	
B1	4	4	4	4	4	4	4	4	4	4	2	4	4	4	1	2	2	59
D2	4	4	4	4	4	4	4	2	4	4	1	4	4	4	4	2	1	58
G	4	2	4	4	4	4	2	4	2	4	4	4	4	4	1	2	2	55
E	4	4	4	4	2	4	4	2	4	4	4	4	2	2	1	1	1	51
B2	4	4	4	4	4	4	4	1	4	4	2	0	4	0	4	1	1	49
C1	4	4	4	4	4	1	2	4	2	1	4	1	1	1	4	4	1	46
I	4	4	4	0	1	4	2	1	1	4	4	4	1	0	1	0	2	37
D1	4	4	0	4	4	0	2	0	0	0	4	4	0	2	4	4	0	36
A	4	4	4	4	4	4	0	1	4	0	0	0	0	2	0	0	0	31
C2	4	2	4	4	0	0	4	4	2	1	0	0	0	0	1	0	0	26
H	4	4	4	0	0	0	4	4	0	2	0	0	2	1	0	0	0	25
F	2	2	1	4	4	4	0	2	2	0	0	0	0	1	0	0	0	22
Student totals	**46**	**42**	**41**	**40**	**35**	**33**	**32**	**29**	**29**	**28**	**25**	**25**	**22**	**21**	**21**	**16**	**10**	

Key to use of genre feature

4	Successful
2	Partially successful
1	Unsuccessful
0	Feature not used

Key to genre feature codes

A	The novelty (newness) of the new research is emphasized.
B1	The results of the research are emphasized.
B2	A simplified version of the methodological procedures and/or theories may be introduced if thought to be of interest to the reader.
C1	Name and position of researchers given
C2	Direct and indirect quotes used from researchers
D1	Simile can be used to relate complex processes/ideas to everyday ideas and events.
D2	Techniques used to help the reader with new knowledge
E	Attitude of writer stated frequently (through use of attitude markers)
F	Less caution used with claims/Doubts removed/ Significance of claims upgraded/ Hedging combined with boosting
G	We/our/us used by writer to express a shared view of the world
H	The reader is directly addressed through use of "you."
I	Questions used to engage the reader

Table 3b: Total score of genre features organized by student

Student	Genre Features A	B1	B2	C1	C2	D1	D2	E	F	G	H	I	Total Score by Student	Band
S6	4	4	4	4	4	4	4	4	2	4	4	4	46	
S13	4	4	4	4	2	4	4	4	2	2	4	4	42	**High**
S10	4	4	4	4	4	0	4	4	1	4	4	4	41	
S5	4	4	4	4	4	4	4	4	4	4	0	0	40	
S4	4	4	4	4	0	4	4	2	4	4	0	1	35	
S8	4	4	4	1	0	0	4	4	4	4	0	4	33	
S3	0	4	4	2	4	2	4	4	0	2	4	2	32	
S1	1	4	1	4	4	0	2	2	2	4	4	1	29	**Medium**
S17	4	4	4	2	2	0	4	4	2	2	0	1	29	
S12	0	4	4	1	1	0	4	4	0	4	2	4	28	
S2	0	2	2	4	0	4	1	4	0	4	0	4	25	
S15	0	4	0	1	0	4	4	4	0	4	0	4	25	
S9	0	4	4	1	0	0	4	2	0	4	2	1	22	
S14	2	4	0	1	0	2	4	2	1	4	1	0	21	
S16	0	1	4	4	1	4	4	1	0	1	0	1	21	**Low**
S11	0	2	1	4	0	4	2	1	0	2	0	0	16	
S7	0	2	1	1	0	0	1	1	0	2	0	2	10	

Key to use of genre feature

4	Successful
2	Partially successful
1	Unsuccessful
0	Feature not used

Key to genre feature codes

A	The novelty (newness) of the new research is emphasized.
B1	The results of the research are emphasized.
B2	A simplified version of the methodological procedures and/or theories may be introduced if thought to be of interest to the reader.
C1	Name and position of researchers given
C2	Direct and indirect quotes used from researchers
D1	Simile can be used to relate complex processes/ideas to everyday ideas and events.
D2	Techniques used to help the reader with new knowledge
E	Attitude of writer stated frequently (through use of attitude markers)
F	Less caution used with claims/Doubts removed/ Significance of claims upgraded/ Hedging combined with boosting
G	We/our/us used by writer to express a shared view of the world
H	The reader is directly addressed through use of “you.”
I	Questions used to engage the reader

Features used with low success
Unsurprisingly D1 (Simile) was only attempted by 10 out of 17 students but the majority of those who did attempt this feature used it well. Features A (Emphasizing newness), C2 (quotes) and H (addressing the reader with "you"), were not attempted by many students but those who did tended to use these features successfully. It was made clear to students that C2 (quotes) was not likely to be used as the students would be unlikely to interview the scientists. However, some students did manage to find some quotes in popular science sources. The most difficult feature to use correctly appeared to be F (playing up success/minimizing doubt/ hedging combined with boosting).

Research question 2: Which factors affect students' ability to incorporate and successfully use the features?
When ranked by individual student score (Table 3b) it is clear that students are clustered into three bands: high proficiency users (scoring between 46 and 40), medium proficiency users (scoring between 35 and 25) and low proficiency users (scoring between 22 and 10). The following sections relate the participants' perceptions (as expressed in the interviews) to their performance as demonstrated by their ability to use the genre features.

Usefulness of writing a PSA
In the high band 3 out of 4 students found writing a PSA useful. In the medium band only 2 students out of 8 found popular science writing useful. In the low band writing PSAs were found to be useful by 3 students out of 5. This suggests that, overall, students' perceptions of usefulness of writing a PSA does not have an impact on students' ability to use PSA features.

Ease of choosing a topic and relation of topic to major
Ease of choosing a topic seemed to be more significant for the higher band, as three of these students stressed that they spent time finding a topic and doing research on the topic. It does not seem to be significant for the medium and low bands as the ease of finding a topic varied. Choosing a topic different to their major only seems to be a factor for those students majoring in Actuarial Science (3 in the medium band and 1 in the low band). All the other students except S6 chose topics connected to their major.

Finding and using sources
It was stressed to students during the course that they should read RAs to obtain scientific information about their topic and PSAs to notice the style of PSA writing, for ideas for their topic, and for the aspects of science they should include.

Ease of finding sources seems to have had an impact on the low band as they tended to express difficulties, but not the high or medium bands. Students in all bands read RAs and found them difficult. Some of the students in the low and medium bands used reading strategies but the students in the high band seemed to be the most proficient and confident readers. While all students read PSAs, the students in the high band seemed to read most widely, for example journal articles, newspapers articles, both academic and general reference books, and government reports (Student 6), a number of RAs after initially reading popular science (Student 10), and other articles from specific popular science journals as "the academic stuff was too difficult" (Student 5). Student 13 commented that as her chosen topic involved mathematics "which links everything" and that she had to go through a chain of RAs to gain a better understanding of her topic, she said "I had to go through the chain to understand the chain." In contrast, the

students in the medium and lower bands seemed to read only the student samples. Overall, the high band seemed to read more widely, make more use of reading strategies, and be more confident readers.

Linguistic ability of students
The high band tended to have a higher standard of written English, and the lower band a lower standard, although this was not always the case. S6 identified himself as a native speaker, and was the most successful in using the genre features. He did, however, stress that he did not find writing a PSA an easy task.

Helpfulness of course materials
In general all the students in all three bands tended to report that they found the course materials useful: "the materials are useful for framing ideas for the PSA" (Student 13: high band), "I referred back to this [the genre features table] a lot when writing the final draft …", and the genre features table is "like a template, useful, and what you should write in a PSA but it would be more useful to just focus on the PSA in the table" (Student 16: low band). S6 (from the high band), the exception, identified himself as having grown up in an English speaking household and his spoken and written English is native-speaker like. He commented that the materials were not particularly useful as they were "more like a reminder than learning new things."

The annotated bibliography materials received positive feedback from all three bands while the genre features materials received mixed feedback from the higher band students and positive feedback from the medium and lower bands. All four high band students commented that they liked the materials on analogy and metaphor, and S5 ("It made us think. I like that"), S13 ("It was interesting and we can apply this but may not need this in future work") and Student 6 ("The lesson was useful but it was difficult to use those [features] in the article.") used this feature successfully in their article. The feedback on the analogy and metaphor materials was mixed from the medium and lower bands.

Research question 3: The pedagogical implications of the findings
After analysing the data a number of pedagogical implications became apparent which will be discussed below.

Out of class vs in class learning
In general most of the students seemed to find the in-class materials which focused on writing useful, yet the students showed a varying ability to use the PSA genre features successfully. From the interview data, the most proficient students seemed to read more widely outside the class either to decide on a topic or to research a topic. This reading tended to be of PSAs or RAs. While all students in their individual interviews said that they read PSAs and RAs the students in the high proficiency band appeared to have more effective reading strategies for RAs and appeared to read more PSAs. Student 6 commented that RAs were "quite hard to understand as these were not related to my major." He found review articles first, and then read only the abstracts and conclusions of academic papers, finding that many of these were specific to the field of his chosen topic. He then cross-referenced the relevant sources with other papers and reviewed the information. Student 10 commented that he "Tried to skip the more technical part. If I can't understand then the audience can't either. I focused on areas that were easy to understand, for example stats." Student 13 seemed to spend more time than the other students researching and reading RAs. She said "There were a lot of sources but it was

not easy to find ones to use. They were sometimes too deep and I couldn't understand the content." However, she added "I did gain knowledge during my research but I think my article is lacking in depth and knowledge.

Comments from the interviews indicated that the higher band students had more motivation to read and research their topic. For example, Student 10 commented "It really took me some time to get to articles and search for ideas. It took me a day or two to browse science news to find a topic. It took time but overall the search was not difficult." Student 6 "wanted to do a topic which is not that popular and so I had to do research to learn more from that field." In contrast, the less proficient students tended to have fewer reading strategies for RAs and only appeared to read the student samples of PSAs.

This suggests two main pedagogical implications. Firstly, out of class reading can be promoted to the students very early on in the course. Secondly, students could be given reading strategies, particularly for RAs as this could help to motivate the students with their reading research. In fact, in later versions of the course, materials on reading strategies for RAs have been included. Although students may not be at that point in their academic studies where they can read RAs, some course designers believe that students will begin to recognize technical terms related to their discipline and that students can be introduced to some more straightforward RAs (Yeong, 2014).

Writing tasks for actuarial science students

In different universities Actuarial Science may appear in the Faculty of Business or the Faculty of Science which suggests its students are, at best, not mainstream science students. In fact, the Actuarial Science students were most vocal about the unsuitability of the PSA component for their learning needs. This suggests the need for a course specifically for those students and probably also for students of Risk Management and Statistics. It seems that these students do not engage in much writing overall.

Conclusion

The overarching question for this study is whether popular science is a suitable writing task for this very mixed cohort of science students. As evidenced by the data, the answer is complicated. Some students can clearly see the value of this task, while others think it is not very useful. Course designers can try to make students aware of the underlying skills developed while writing popular science, and can make improvements to the in- and out-of-class materials in order to try to sell the idea to students.

This study shows that students can incorporate and successfully use genre features of popular science in their writing to varying extents, although some students have done it extremely well. The factors which determine student incorporation and use of the genre features seem to be motivation to do the research and particularly to read; in other words the out-of-class work is crucial. The pedagogical implications are undoubtedly mixed. It seems that the most important implication is to strive to increase student motivation, particularly for learning and studying which takes place outside the classroom.

About the author

Simon Boynton works at the Centre for Applied English Studies at the University of Hong Kong. He has been the Programme Coordinator for Science and is currently the Programme Coordinator for Medicine. His research interests include assessment, undergraduate writing, and English-in-the Discipline.

Reference list

Braine, G. (1989). Writing in science and technology: An analysis of assignments from ten undergraduate courses. *English for Specific Purposes, 8*(1), 3-15

Hyland, K. (1996). Talking to the academy: Forms of hedging in science research articles. *Written Communication, 13*, 251–281

Hyland, K. (1998). *Hedging in scientific research articles*. Amsterdam: John Benjamins.

Hyland, K. (2010). Constructing proximity: Relating to readers and popular and professional science. *Journal of English for Academic Purposes, 9*, 116-127

Jackson, L., Meyer, W., & Parkinson, J. (2006). The writing tasks and reading assigned to undergraduate science students. *English for Specific Purposes, 25*(3), 260–281

Lemke, J. L. (1990). *Talking science: Language, learning and values*. Norwood, NJ: Ablex.

Parkinson, J. (2000). Acquiring scientific literacy through content and genre: A theme-based language course for science students. *English for Specific Purposes, 19*, 369–387

Parkinson, J., & Adendorff, R. (2004). The use of popular science articles in teaching scientific language. *English for Specific Purposes, 23*(4), 379–396

van Dijk, T. A. (1988). *News as discourse*. Hillsdale, NJ: Lawrence Erlbaum.

Yeong, F. M. (2014). *How to read and critique a scientific research article: Notes to students reading primary literature*. Singapore: World Scientific.

Appendix 1: Course materials summarising the main differences between research articles and popular science articles (based on the work of Hyland, 2010)

Feature	Features of Research Articles (Specialist reader)	Features of Popular Science Articles (Non-specialist reader)	Use for your article?
A. How new ideas are represented	**For new research:** **Novelty (the new research) is carefully introduced** as the researchers don't want to upset previous researchers. Previous research is referred to, a gap in the research identified, and then the new research introduced.	**For new research:** **The novelty (newness) of the research is emphasized** as novelty means interest for the reader. In the first paragraph of the article (sometimes even the first sentence) phrases such as "new research shows that…" are often present.	✓
B. Explaining methodological procedures and theories	**Science research articles have very detailed description of methodological procedures** to show that verifiable scientific procedures have been followed. **In other words the procedures are emphasized (and given more space) rather than the results.** **Specialized technical language used as "shorthand" between writer and reader** Examples of this include: ➢ technical terminology (e.g. photodisociation, a mixture of n ¼ 2 s and p states) ➢ acronyms (e.g. VMI, MCP, CCD camera) ➢ reference to routine procedures for that field (e.g. collimating, photodisociation) ➢ reference to specialized forms of equipment (e.g. dual microchannel plate (MCP) detector)	**In Popular science articles results of the research are emphasized** as these are of more interest to the non-specialist reader. **A simplified version of methodological procedures and/or theories** may be introduced, if this is thought to be of interest to the reader. This simplified version is often present in full-length/feature-length articles in popular science magazines.	✓ ✓
C. How the credibility of the researchers is represented	**Impersonal structures are used in order to emphasize the credibility of the researchers.** ➢ Tables and figures become subjects of sentences ➢ Dummy it sentences (e.g. it is important to see) ➢ What is clear is that… (an impersonal construction)	**Name and position of researchers given** in order to emphasize their credibility to the reader. **Direct and indirect quotes used from researchers.**[1]	✓ ?

[1] Authors working for popular science magazines have an opportunity to interview researchers. Since students in this course are unlikely to be able to do this, it is unlikely that their articles will contain direct quotation.

Feature	Features of Research Articles (Specialist reader)	Features of Popular Science Articles (Non-specialist reader)	Use for your article?
D. Helping the reader to easily follow the article	**The reader is familiar with complex processes and ideas, and already understands the science.** ➢ **Most concepts will not be new to the reader** ➢ **Technical terms are used throughout the article as a form of shorthand** ➢ **Clarifications rarely needed** **Lack of explicit cohesion**	**Simile can be used to relate complex processes/ideas to everyday ideas and events,** making it easier for the reader to understand the science. Other ways to help the reader with new knowledge include: ➢ **New concepts are defined as they are introduced** ➢ **Technical terms are avoided whenever possible or glossed** ➢ **Clarifications are used for unfamiliar usage of terms** **Cohesion made explicit** through: ➢ The use of repetition ➢ Phrases and relative clauses used to explain/define terminology and new concepts to the reader ➢ Use of this/that/these/those to refer back to previous ideas/concepts/terminology ➢ Synonyms ➢ Lexical sets (sets of vocabulary)	✓ ✓ ✓
E. Writer attitude (stance)	**Attitude of writer stated rarely** in order to increase the objectivity of the research and the persuasiveness of the arguments	**Attitude of writer stated frequently (through use of attitude markers)** • Attitude markers used to give writer's responses to the subject matter, pointing out what is important and encouraging readers to engage with the topic • These help to give a more informal tone and to underline the accessibility of the material	✓
F. Strength of claim and location of main claim	**Hedging used to show caution with claims** • Hedging used (especially in the results section) to avoid the risk of inviting rejection of findings and arguments from other researchers • Hedging also used to show a degree of caution attached to an argument or statement	**Less caution with claims.** • Doubts in the research tend to be removed or minimized. • Significance of the claims and findings are upgraded to emphasize their uniqueness, rarity or originality. • Hedging is still used but can be combined with boosting (e.g. "potentially revolutionary", "this may be the most significant find yet")	✓ **But** don't make a claim which is not supported)
G. Use of "we"	**"We" can be used to refer to the scientific community**	**"We" and "us" refer to reader and writer** to express a	✓

Feature	**Features of Research Articles (Specialist reader)**	**Features of Popular Science Articles (Non-specialist reader)**	**Use for your article?**
	and express shared ideas and goals (in other words to express solidarity). **It can also be used to refer to the writers.**	shared view of the world.	
H. Use of "you"	**The reader is not usually addressed directly** as this is considered too direct (i.e. "you" not used)	**Reader can be directly addressed.** • "You" can be used by the writer to try to draw the readers into the world of science and try to involve them in the topic of the article.	✓
I. Use of questions	**Questions rarely used.** However, they can be used to present a hypothetical question to which the answer is not yet known. This question may then be answered in the article. This is to generate interest for the reader.	**Questions more frequently used.** • Present the researcher's problems as questions (which will hopefully be answered in the article) • Ask questions that the reader might have about the topic • Ask the reader questions directly • These questions help to involve and interest the reader, bring the reader closer to the science and the researcher, and to make the science more "real."	✓

Appendix 2: Individual interview questions

1) Did you find writing a popular science article useful? Why / Why not?

2) How easy was it for you to find a topic to write about? Was the topic connected with your major or minor?

3) How easy was it for you to find useful sources for your topic? Which sources did you use?

4) Did you read any research articles? If so, how easy were they to understand? Did the course materials help you with reading research articles?

5) Did you read any popular science articles during the course? If so, did you find these helpful in writing your popular science article?

6) Did you find the course materials useful for writing your popular science article? Which materials in particular did you find helpful or unhelpful?

   - Finding and evaluating sources
   - Introduction to Annotated Bibliography
   - Summarizing and paraphrasing in science writing
   - Genres of science writing: research articles vs popular science articles
   - Outlining and structuring your writing
   - Analogies and metaphor
   - Using/creating visuals

7) Have a look at the genre features of science writing which were covered on the course (show the relevant materials from the course). Which of these features did you try to use in your popular science article?

8) Which of these features do you think you used successfully?

9) Were any of the features difficult to use in your popular science article?

10) Do you have any suggestions on how we can change or adapt the course materials to help students write popular science articles? What would be more helpful for your learning style?

11) Are there any other forms of science writing that you think it would be helpful to focus on in the science course?