HARMONISING THE TEACHING OF SCIENTIFIC COMMUNICATION SKILLS THROUGH THE DEVELOPMENT OF AN E-LEARNING TOOL

Amber J. Willems-Jones[a], Joanne M Russell[b], Jiang-Li Tan[a] and Nicole Kountouri[a].

Presenting Author: Amber Willems-Jones (awillems@unimelb.edu.au)
[a] School of Biomedical Sciences, The University of Melbourne, VIC 3010, Australia
[b] Melbourne Medical School, The University of Melbourne, VIC 3010, Australia

KEYWORDS: science communication, scientific report writing, e-learning, student engagement, feedback, teaching and learning.

ABSTRACT

Effective communication is a fundamental skill within all professions and is espoused as an attribute of the University of Melbourne graduate. University graduates are expected to be critical thinkers who can apply their knowledge and research skills to solve complex problems in a range of contexts. Developing and applying these skills requires a consistent approach to teaching and assessment of scientific communication at the undergraduate level. Despite being taught by leading academics with an abundance of scientific communication experience, anecdotal student feedback suggests that instruction on scientific writing across disciplines varies; creating student confusion and a lack of confidence in scientific literacy more broadly. Given the importance of preparing research-ready graduates, our project adopted a multidisciplinary approach to harmonise teaching scientific communication skills across the School of Biomedical Sciences. This was achieved through the development of an e-learning module designed to teach the requisite skills that can be applied across all forms of scientific communication. The module is innovative in enhancing students' scientific literacy skills. Students will practice, demonstrate and further develop critical thinking and communication skills, as well as improve their understanding of scientific writing by completing the activities embedded within, with the added benefit of improving employability by strengthening their understanding of scientific communication (and associated skills).

AIMS

The initial aim of the project was to identify and harmonise the teaching practices and content considered as core to the teaching of scientific report writing within the six undergraduate teaching departments of the School of Biomedical Sciences (SBS). The subsequent aim of the project was to use these findings to inform the design and development of a school-wide e-learning module for undergraduate students to learn the processes and conventions of scientific report writing; a module that could be made widely available to students across the University as an additional resource through the University of Melbourne's Academic Skills Hub.

BACKGROUND

Effective communication is fundamental for science graduates entering the 21st century workplace. The development of good scientific writing skills is vital for undergraduate science students (Reynolds, *et al.,* 2011) and competence in scientific writing can have a positive impact on a range of related skills, including communication skills, scientific content knowledge, critical thinking and problem solving (Tonissen et al., 2014). Moreover, such communication skills are highly valued by employers in the STEM field (Rayner & Papakonstantinou, 2015), making effective communicators more employable upon graduation. Developing these skills and recognising how they can be used in a variety of contexts will be enhanced by a consistent approach to teaching and assessment of scientific writing (Jones & Harris, 2012).

The Melbourne Graduate is a critical thinker who can apply their knowledge and research skills to solve complex problems in a range of contexts and communicate this information effectively. Students in the School of Biomedical Sciences (SBS) develop scientific analysis, critical thinking and communication skills through scientific report writing. However, curriculum structure and delivery, learning tasks and assessment in this area is diverse across the school's five disciplines that teach scientific report writing: Anatomy & Neuroscience; Biochemistry & Molecular Biology; Microbiology & Immunology; Pathology; and Physiology. Current methods for teaching scientific report writing (henceforth to be referred to as scientific writing) across SBS are largely dependent upon the individual teaching academics in each discipline. Despite being delivered by leading academics with an abundance of scientific writing experience, anecdotal student feedback suggests diverse expectations between disciplines, creating reported confusion amongst students and a lack of

confidence in their overall scientific literacy. For example, a Pathology teaching academic in SBS anecdotally reported that students often ask, "*why do Pathology reports require an abstract when Biochemistry reports do not?*" Similar student feedback, related to other aspects of scientific writing, has been reported across the other SBS subjects, prompting a school-wide interest in addressing these inconsistencies.

Inconsistencies in the teaching and assessment of scientific report writing between scientific disciplines are likely to arise from the experience and expectation of individual academics, a lack of collaborative curriculum design around the teaching of scientific writing and possibly legitimate differences in the requirements of scientific writing in different disciplines. While some differences are expected given the nature of the scientific information to be communicated by each specific discipline, it is important that students understand the essential features common to all scientific writing and communication. Given the importance of preparing research-ready graduates equipped with skills including effective scientific communication, critical thinking and proficiency in scientific analysis; this project proposed a school-wide approach to improve the quality and effectiveness of students' learning experiences through teaching excellence in scientific writing.

A harmonised approach to the teaching of scientific writing across the school is anticipated to provide clearer messages to students, strengthening their afore-mentioned skills, thus improving student employability. It will establish a basis for stringent and consistent assessment, and furthermore, define a minimum standard for scientific writing across the school.

METHOD

PARTICIPANTS AND SUBJECTS

Ten teaching academics (teaching specialists or teaching & research academics) from five of the six SBS disciplines (excluding Pharmacology as they do not teach scientific writing) provided scientific writing and communication teaching materials (e.g. instructional guides, marking rubrics, handbooks, assessment requirements, tutorial notes) for analysis. A total of 13 subjects for the Bachelor of Science and Bachelor of Biomedical Science degrees were represented. Table 1 outlines the subjects and disciplines analysed in the study.

Table 1: Contributing subjects that teach scientific writing within the School of Biomedical Sciences (SBS).

SBS Discipline	Subject code and Name	Year Level[a]
Anatomy and Neuroscience	CEDB30002: Concepts in Cell & Developmental Biology	Yr 3
	CEDB30003: Developmental Biology	
	CEDB30004: Stem Cells in Development & Regeneration	
Biochemistry and Molecular Biology	BCMB20005: Techniques in Molecular Science	Yr 2
	BCMB30002: Functional Genomics and Bioinformatics	Yr 3
	BCMB30004: Cell Signalling and Neurochemistry	
	BCMB30010: Advanced Techniques in Molecular Science	
Microbiology and Immunology	BIOM30003: Biomedical Science Research Project	Yr 3
	MIIM30016: Techniques in Microbiology	
Pathology	PATH20003: Experimental Pathology	Yr 2
	PATH30002: Techniques for Investigation of Disease	Yr 3
	PATH30004: Advanced Investigation of Human Disease	
Physiology	PHYS20009: Research-based Physiology	Yr 2

[a] First-year subjects (e.g. Biology and Chemistry) were not included as these broad subjects are not delivered by SBS.

EXPLORING CURRENT TEACHING OF SCIENTIFIC WRITING ACROSS SBS

Initially, to explore the student perception of the teaching of scientific writing in SBS, an online survey was deployed to past (2016) and current (2017) Honours students from SBS. The purpose of this survey was to understand how prepared students felt from their undergraduate study in SBS, to embark on an Honours research project and write a minor thesis. It also aimed to identify areas for improvement in the teaching of scientific writing and communication in SBS.

Turning our attention to current teaching practice in this area, an online survey was deployed to teaching academics to explore the methods of delivery used to teach scientific writing in each discipline (e.g. is scientific writing taught via lecture or during a small group tutorial?).

Thematic analysis of the teaching materials in each discipline was subsequently conducted to explore the current teaching of scientific writing in SBS. In this context, a theme was defined as either a 'teaching practice' or a 'report section'. A 'teaching practice' was defined as the provision, by the teacher, of information necessary for a student to learn the skills of scientific writing and communication (i.e. what the teacher does or provides to teach these skills). A 'report section' was defined as an essential (core) requirement for writing a scientific report (i.e. a content item that a student must include in their report for that subject). Instruction on *what* report sections to include, as well as *how to write* each report section, were both explored.

Thematic analysis results were cross-checked by teaching academics to ensure the data was an accurate representation of the teaching of scientific writing in SBS.

HARMONISING THE TEACHING OF SCIENTIFIC WRITING ACROSS SBS

The teaching of scientific writing, including what and how to write ('report sections') and how it is taught ('teaching practices'), was compared between the disciplines of SBS, across second and third year subjects. Similarities and differences were discussed amongst teaching academics from all disciplines to identify differences related to discipline-specific requirements (i.e. necessary variation between scientific writing in each discipline), and differences related to other factors, such as habit, tradition or personal preference of the academic (i.e. unnecessary variation). Disciplinary differences that were deemed "necessary" were to be highlighted and explained in the e-learning module. Other "unnecessary" differences were discussed amongst academics and a consensus was reached to ensure a harmonised approach to teaching these common aspects within the e-learning module.

DEVELOPMENT OF THE E-LEARNING MODULE

Harmonised content, common to all disciplines, was prepared in the form of a skeleton lesson of *what* students should include in a scientific report. From this skeleton, information was added on *how to write* each report section. Due to the lack of existing instruction of how to write scientific reports, the authors co-constructed instructions for approaching the writing of each report section, which was reviewed and approved by teaching academics. To strengthen the focus on *how to write* a scientific report, teaching academics were also asked – through an online survey – to identify the order in which they actually write each section of their own scientific reports. The e-learning module was arranged in this order to reflect authentic scientific writing practice.

The e-learning module was developed using the Smart Sparrow platform. The authors collaborated with a learning designer from Smart Sparrow to build the module based on the skeleton content, with activities built into the module to aid student learning at each section. Existing teaching practices, particularly those common to all disciplines, were incorporated into the design of the e-learning module to ensure that existing quality teaching practice in this area continued within the School.

RESULTS/DISCUSSION

TEACHING OF SCIENTIFIC WRITING IN SBS

Student perception of the teaching of scientific writing in SBS

As educator perspectives on student learning is often misaligned with student perspectives on their own learning, it was important to consider both perspectives when designing the e-learning module to improve student learning (Sabeh *et al.*, 2011). A survey was designed and deployed to SBS Honours students to obtain their perspectives on the teaching of scientific writing and communication. Unfortunately, there was a low response rate from former (2016) and current (2017) Honours students (19/189 responses), but we present the findings from this 10% of Honours students here:

- 63% respondents felt that their experience in scientific writing in SBS has (or had) adequately prepared them in writing their Honours thesis
- 85-90% respondents felt that (a) having access to an example of a good scientific report, (b) having access to a marking rubric for their scientific writing assessments, and (c) receiving feedback on their own report writing was useful in developing skills for scientific writing

- 85-90% respondents stated that there should be more consistent teaching of scientific writing across all subjects in SBS
- 100% of respondents felt that there should be more focus on *how* to write a scientific report, not just what should be in it.

When asked to reflect on their current skills in written scientific communication, 10/19 respondents reported that they still had a lot more learning to do: *"I still feel like I have a lot to learn. I feel like this is something that takes time and practise though"* (Honours student survey respondent).

Encouragingly, most respondents (17/19) acknowledged the importance of scientific communication skills to their future employability, with one Honours student providing this comment in response to the question "Do you believe that written scientific communication skills will continue to be of value in your future endeavours": "*Yes, especially considering I want a career in science. You can't be in this field without having a good grip on scientific writing*" (Honours student survey respondent).

Teaching practices related to scientific writing in SBS

Not all SBS disciplines teach scientific writing to students at both second year (Yr2) and third year (Yr3) levels. Of the five analysed disciplines, three disciplines (Biochemistry & Molecular Biology, Pathology and Physiology) provided instruction on scientific writing in Yr2; while four disciplines (Anatomy & Neuroscience, Microbiology & Immunology, Biochemistry & Molecular Biology, and Pathology) covered this content in Yr3 (Tables 2 and 4). Students studying subjects from Biochemistry & Molecular Biology and Pathology were taught scientific writing at both Yr2 and Yr3.

An online survey was conducted to confirm the methods of delivery used to teach scientific writing in each discipline. Survey responses indicated that most disciplines used at least two delivery methods to deliver teaching of scientific writing (Table 2). The most common methods of delivery included tutorials, workshops and practical classes; however, delivering scientific writing instructions through tutorials and practical classes predominated in Yr3. The Pathology practical classes also incorporated demonstrator tutorials for evaluating report writing and providing feedback to students on their scientific reports. The delivery methods used across SBS were important to consider, to inform the design of the e-learning module so that it is practical for educators to deliver the teaching of scientific writing in a similar manner, without introducing major curriculum change.

Table 2: Methods for delivering scientific writing instructions, guidance or activities.
Data were generated through an online survey. Participants included seven SBS teaching academics who teach scientific writing. ANAT = Anatomy & Neuroscience; BCMB = Biochemistry & Molecular Biology, MIIM = Microbiology & Immunology; PATH = Pathology. Note: no response was received by Physiology for this survey.

	Second Year (Yr 2)				Third Year (Yr 3)			
Teaching Delivery Method	**ANAT**	**BCMB**	**MIIM**	**PATH**	**ANAT**	**BCMB**	**MIIM**	**PATH**
Lecture				✓			✓	✓
Tutorial		✓				✓	✓	✓
Workshop				✓	✓	✓		
Practical		✓		✓	✓	✓		✓
Laboratory Manual		✓				✓		
Learning Management System				✓				✓
Online Task / Activity				✓				✓

Thematic analysis was used to explore the collated teaching materials from across SBS for teaching practices related to the teaching of scientific writing. A total of 13 teaching practices were identified, coded and grouped into learning and teaching categories (Table 3).

Teaching what and how to write

Regarding the core (required) report sections, it was evident that all participating disciplines instructed on the importance of Aims, Materials & Methods, Results, Discussion, Conclusion and References.

Most disciplines also taught the importance of Title and Introduction, and some also taught and assessed the Abstract and Hypothesis. Other less commonly required sections – Declaration, Acknowledgement, Table of Contents, List of Table and Figures and Appendix – reflected the specific learning objectives of individual subjects. In the disciplines that taught scientific report writing at both year levels, report sections that were considered 'core' were taught in both Yr2 and Yr3.

There were some examples of teaching students *how to write* the specific sections or components; for example, Pathology teaching materials included 'steps for writing an abstract'. However, most teaching instruction on writing a scientific report, focused on *what* to include in the report, rather than *how to write* it.

Variation in the teaching of scientific writing across SBS

Across the School, disciplines utilised various teaching practices to educate students on scientific report writing. The data indicated that teaching practices related to scaffolding or fostering a more basic level of understanding (via instructions or resources) were more common in Yr2 than in Yr3. Teaching practices that focused on extending student knowledge and skill (practices A, B, E, F, I, J, L, M and N) were more common in Yr3 than in Yr2. Practice G – providing examples of scientific reports (or sections of) – was the only teaching practice that was utilised equally from Yr2 to Yr3 (Table 3).

In addition to the variation across year levels, analysis of teaching *materials* also highlighted variation in teaching *practices* between disciplines (Table 4). All analysed disciplines outlined the general rules for writing a scientific report (Practice A) and provided details and elaboration on the requirements of each report section to guide report assembly (Practice B) at Yr2 and Yr3. For disciplines who taught at Yr2 (Pathology, Physiology and Biochemistry & Molecular Biology), all guided the literature search process (Practice C) and the use of scientific language (Practice D). Furthermore, students in Yr2 within these subjects were also provided with scientific report examples (Practice G) as well as resources related to literature searching (Practice H). A formative assessment of student understanding of scientific writing rules and features (Practice K) also featured in all subjects that teach scientific writing in Yr2. All disciplines in Yr3 provided a marking guide and/or rubric to students (Practice I) in addition to practices A and B.

Consistent across the school was a general lack of instruction on *how to write* a scientific report, in contrast to the abundance of information on *what* to include.

It is of interest to note that although some aspects of the teaching of scientific writing were inconsistent across the school, the key concepts of scientific communication and essential characteristics of a scientific report were, fortunately, consistent. Analysis of the teaching of scientific writing across 13 SBS subjects suggests that student feedback on inconsistent teaching of scientific writing must relate to the delivery and presentation of instruction on scientific writing, and the specific assessment requirements for each scientific report, rather than the key concepts and conventions of scientific writing and communication more broadly. For this reason, there were no "necessary" disciplinary differences to highlight and explain in the e-learning module.

HARMONISED TEACHING OF SCIENTIFIC WRITING: THE E-LEARNING MODULE

The e-learning module was developed as a harmonised multidisciplinary educational tool to teach the principles of scientific writing and communication. In contrast to the presentation of sections in a scientific report (i.e. the order in which it reads from start to finish) – which begins with a Title and ends with a Reference List – a scientific report is usually written in a different sequence. An online survey was utilised to gauge the sequence in which the University's teachers and researchers commonly write the sections of a scientific report. This writing sequence was incorporated into the e-learning module: Results>Method>Introduction>Discussion>Conclusion>Abstract>Title>References.

Table 3: Identification, coding and categorisation of scientific writing teaching practices in the School of Biomedical Sciences (SBS).

Teaching Practice Category	Teaching Practice Code	Identified Teaching Practice	Description
Instructions for scientific writing	**A**	Outlines general rules	Outlines general rules for writing a scientific report
	B	Details requirements of each section	Provides details and elaborates on the requirements of each report section to guide assembly
	C	Guides literature search process	Guides or demonstrates the literature search process
	D	Guides use of scientific language	Guides appropriate use of scientific language
	E	Explains how to cite	Explains how to cite and/or describes citation style
Resources	**F**	Provides citation resources	Provides (or provides link to) resources relating to citations and bibliographies
	G	Provides example reports	Provides examples of scientific reports/sections of scientific reports
	H	Provides literature searching resources	Provides (or provides link to) resources relating to literature searching
	I	Provides marking guide/rubric	Provides marking guide and/or rubric to students
	J	Provides plagiarism information	Provides (or provides link to) information on plagiarism (what it is, what the consequences may be)
Assessment	**K**	Assesses understanding (formative)	Directly assesses (formative) student understanding of scientific writing rules and features (e.g. quiz)
Writing context	**L**	Highlights importance	Highlights importance of scientific writing
	M	Presents learning outcomes	Presents learning outcomes of writing task (i.e. what students should achieve/develop through this writing process)

Table 4: Undergraduate scientific writing teaching practices of disciplines within the School of Biomedical Sciences (SBS)
Teaching materials related to scientific writing and communication were provided by seven teaching academics involved in delivering this material across five disciplines within SBS. Materials were analysed and coded according to the themes defined in Table 3. ANAT = Anatomy & Neuroscience; BCMB = Biochemistry & Molecular Biology, MIIM = Microbiology & Immunology; PATH = Pathology; PHYS = Physiology

		Second Year (Yr2)					Third Year (Yr3)				
Teaching Practice Category	**Teaching Practice**	**ANAT**	**BCMB**	**MIIM**	**PATH**	**PHYS**	**ANAT**	**BCMB**	**MIIM**	**PATH**	**PHYS**
Instructions for scientific writing	A. Outlines general rules		✓		✓	✓	✓	✓	✓	✓	
	B. Details requirements of each section		✓		✓	✓	✓	✓	✓	✓	
	C. Guides literature search process		✓		✓	✓	✓	✓			
	D. Guides use of scientific language		✓		✓	✓		✓	✓		
	E. Explains how to cite		✓		✓			✓	✓	✓	
Resources	F. Provides citation resources		✓		✓			✓	✓	✓	
	G. Provides example reports		✓		✓	✓	✓	✓	✓		
	H. Provides literature search resources		✓		✓	✓	✓	✓			
	I. Provides marking guide/rubric				✓		✓	✓	✓	✓	
	J. Provides plagiarism information							✓	✓	✓	
Assessment	K. Assesses understanding (formative)		✓		✓	✓					
Writing context	L. Highlights importance				✓		✓	✓			
	M. Presents learning outcomes						✓		✓	✓	

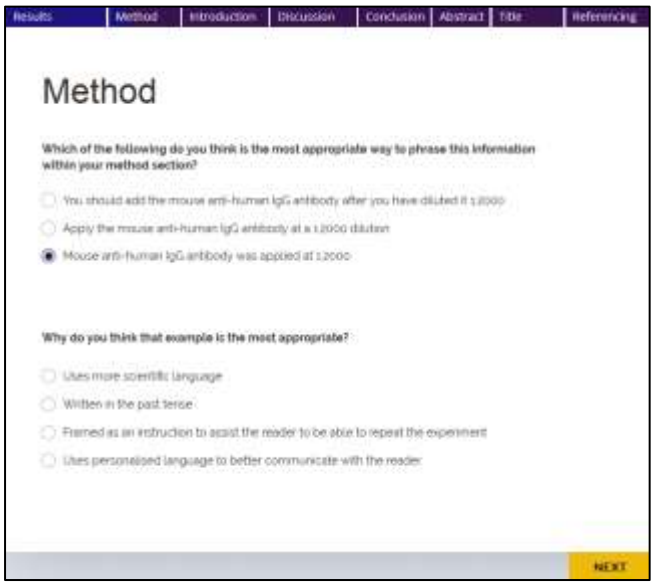
Two learning modules were developed: 1) A basic module (Level 1) with essential information regarding scientific writing presented alongside activities and questions designed to reinforce content knowledge (i.e. what should be in a scientific report) (Figure 1), and 2) an extended module (Level 2) with detailed activities, where students are required to provide input into a report examples and edit/rearrange report elements to learn what makes a great scientific report (Figure 2). Level 2 has been defined as 'report refinement' and students are encouraged to complete the level alongside the construction of their own scientific report to refine and improve their actual writing.

Throughout the learning modules, students are presented with:

- Information on scientific writing (text, images, flowcharts/diagrams)
- Scientific writing examples from scientific publications
- Challenges to assess student understanding of essential report components
- A unique learning experience.

Each level of the e-learning module (Levels 1 and 2) was designed for a student seat-time of approximately 50-minutes due to the preferred method of delivery of teaching scientific writing in SBS. These 50-minute modules can easily be deployed and completed during a 1-hour lecture, tutorial or workshop, or even a longer practical class. To consolidate the learning through this online experience, both Levels 1 and 2 provide a printable checklist at the end of the level, which students can keep for future use. These checklists include concise reminders of the key features and components of a scientific report, as well as tips for refining and improving the quality of their writing.

A.



B.

C.

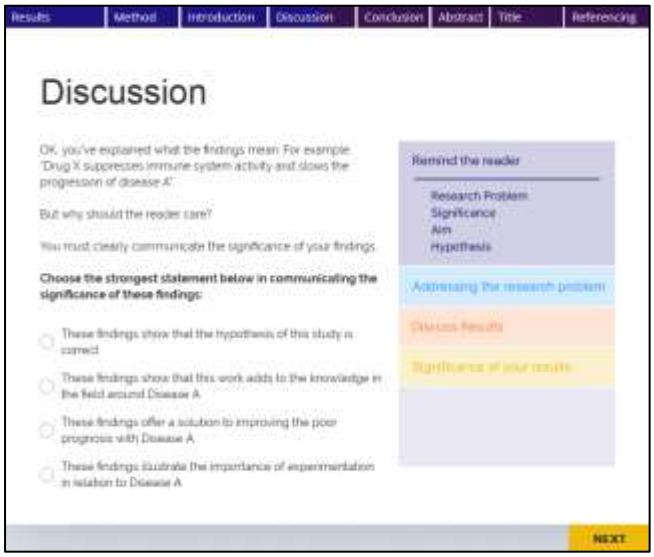
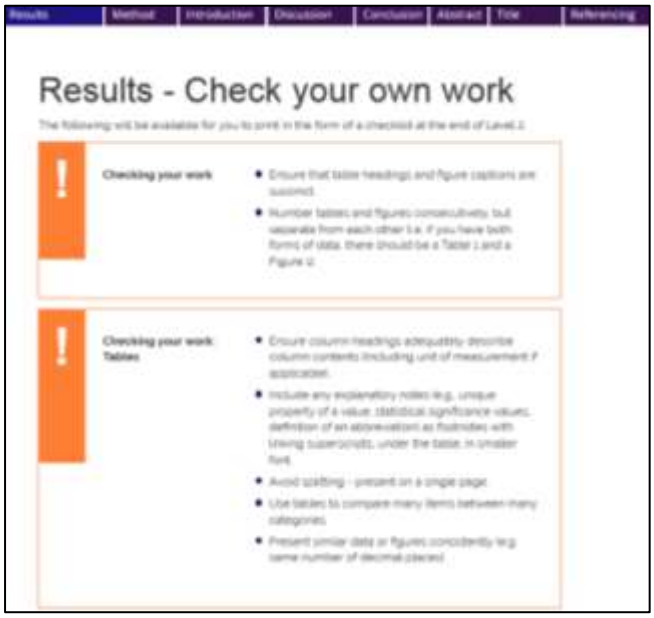


Figure 1: SBS Scientific Communication E-learning module, Level 1: Essential report writing information designed to teach content and structure.

Screen captures from the Level 1 module in which students are presented with structural features of a scientific report, plus activities and questions designed to examine their basic understanding of scientific report writing and scientific communication. A) Method section activity; B) Introduction section activity related to providing published findings that support a hypothesis; C) Discussion section activity related to communicating the significance of research outcomes.

A.



B.

C.

Figure 2: SBS Scientific Communication E-learning module, Level 2: Report refinement.
Screen captures from the Level 2 module in which students are provided with advanced level activities and opportunities to refine their own scientific writing. A) Screen capture of (part of) the Results check list for students to apply to their own scientific report; B) Reflection screen for 'Abstract' designed for students to review their own written abstract and ensure they have applied the relevant conventions to its structure; C) Title keywords screen, designed to have students reflect on their study topic to identify key words and phrases that will aid them in producing an informative and succinct report title.

The educational tool provides an innovative way to enhance the scientific literacy skills of students. Students can demonstrate their critical thinking and communication skills, as well as their understanding of scientific writing by completing activities embedded within the module (Figures 1 and 2).

A common complaint from students is the lack of quality feedback on assessments to enable timely improvement. In most of the scientific writing tasks across the school, assessment and feedback is provided by casual demonstrators. Consequently, the feedback provided – both the amount and quality – can be highly variable. The resource produced by this project provides immediate, adaptive feedback, driven by the student's choices throughout the lesson. An example of the constructive and descriptive feedback provided to students is given in Figure 3.

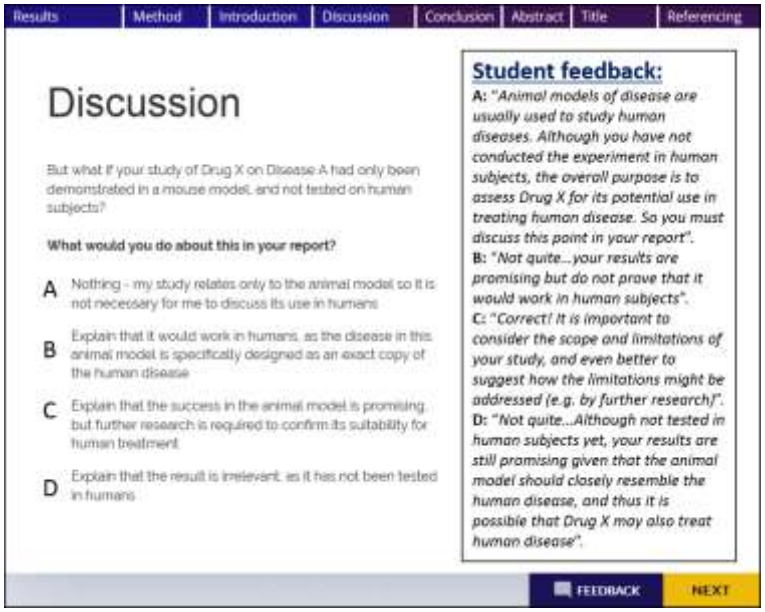


Figure. 3: Adaptive and constructive feedback provided for 'Discussion' section activities in the Level 1 module.
Students are provided with relevant feedback specifically associated with their selected response. Feedback on 'incorrect' answers is designed to provide students with an understanding of why their selection was not correct, thereby aiding in their overall understanding of appropriate scientific communication.

The educational tool also comes with detailed learning analytics, which are invaluable in highlighting areas where students require additional guidance. These analytics include average time spent on each screen and the overall lesson, the number of students who have accessed the learning module and how much of the lesson they have completed, and the pathways of students for individual questions/activities (i.e. how many times multiple answers are selected before the correct one is selected).

Not only is this e-learning module innovative in its incorporation of instruction, activity (for active learning), adaptive feedback and printable checklists for future use, but also in its harmonised delivery across the school. While we believe that the module offers a potential solution to large group teaching (through automated adaptive feedback that does not require time or effort from the teacher); due to time constraints, we have not yet been able to test the impact of the module in a large class. Future analyses of the e-learning module deployment will include investigating the benefits of using the module in a large group setting.

CONCLUSION

Throughout the module, students will experience inquiry-based learning and will benefit from immediate, high-quality feedback. The anticipated benefits to students include improved quality and effectiveness of student learning experiences; reinforcement of scientific writing as a life-long skill, as opposed to a means for passing a subject; a clear understanding of expectations and ability to monitor their own skill development; and enhanced scientific analysis, critical thinking and communication skills.

Furthermore, use of the e-learning module will have benefits to academic staff as well, including: reinforcement of the importance of scientific writing through consistent teaching; improved consistency in feedback; an educational tool that is easy to implement through LMS, and one that provides advanced learning analytics to better understand student skills in scientific writing and a method of objective assessment. In addition, the use of the e-learning module will bring students without scientific writing background up to speed to ensure a more consistent starting point for all students prior to their first written scientific report submission, thereby making marking less arduous.

The e-learning module has been designed for use across SBS in all subjects at the second- and third-year levels, with intellectual input from all departments within the school. The e-learning module could also be adapted for use within the wider STEM community and has been made available through the University of Melbourne Academic Skills Hub.

ACKNOWLEDGEMENTS

This project was supported by the University of Melbourne Learning and Teaching Initiative Grant scheme. Sections of this project (where applicable) were approved by the University of Melbourne MDHS Human Ethics Advisory Group (1749233.1).

REFERENCES

Jones, F. & Harris, S. (2012) Benefits and Drawbacks of Using Multiple Instructors to Teach Single Courses, *College Teaching*, 60(4): 132-139.

Rayner, G. & Papakonstantinou, T. (2015). Employer perspectives of the current and future value of STEM graduate skills and attributes: An Australian study. *Journal of Teaching and Learning for Graduate Employability*, 6(1): 100–115.

Reynolds, JA, Thaiss, C, Katkin, W, & Thompson Jr, RJ. (2011). Writing-to-Learn in Undergraduate Science Education: A Community-Based, Conceptually Driven Approach, *Life Sciences Education*; 11(1):17-25.

Sabeh, G, Bahous, R, Bacha, & N Nabhani, M. (2011). A Match or a Mismatch between Student and Teacher Learning Style Preferences, *International Journal of English Linguistics*; 1(1):162-172.

Tonissen, KF, Lee, SE, Woods, KJ, & Osborne, SA. (2014). Development of Scientific Writing Skills Through Activities Embedded into Biochemistry and Molecular Biology Laboratory Courses, *International Journal of Innovation in Science and Mathematics Education*, 22(4): 1-14.

Proceedings of the Australian Conference on Science and Mathematics Education, Flinders University, 26-28 September 2018, pages 136–147, ISBN Number 978-0-9871834-7-7