Models and Modelling in a Scientific English Writing class

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Models in ‘second’ language writing pedagogy

Models of one sort or another are a key feature of much second-language writing pedagogy, in particular in rhetorical and genre-focussed approaches (Hyland 2007; Jones and Freeman 2003; Nazarenko and Schwarz 2010; Swales and Feak 2004). Teachers may use models to introduce genre, to highlight particular rhetorical, register and linguistic features that students are expected to appropriate in their own compositions. Models can be particularly important when students are introduced to a new genre of composition with which they may be relatively or totally unfamiliar. ‘Authentic’ published texts may be used, edited or unedited, depending on preference and purpose, but teacher- and student-composed models can also be useful, despite claims of ‘inauthenticity’. Although Huttner (2008, 147) states that: ‘expert genres cannot be identical to student genres, and therefore that the former constitute problematic models for student writing’ this is simplistic – given the tools and the content, in the case of this paper a student’s own original experiment, students are very able to learn from ‘expert’ or ‘authentic’ models to craft their own compositions in the AIMRaD (abstract, introduction, methods, results, and discussion) form.

In principle, models are simply examples that offer students a variety of items, whether lexical, rhetorical, stylistic, or structural, to acquire (Jones and Freeman 2003). In this sense, models are scaffolding tools of Vygotskian learning, where students’ current abilities and knowledge and their potentials to produce and acquire something new are bridged by a zone of proximal development – a learning space supported by the models and the tasks set by the teacher (Mercer 2000). Models are widely regarded as an important part of writing pedagogy at all ages and levels, as Gallimore and Tharp (quoted in Jones and Freeman 2003, 169) state:

> Modelling is a powerful means of assisting performance, one that continues its effectiveness into adult years and into the higher reaches of intellectual complexity. In the educational setting, both expert, teachers, and peer models are highly important sources of assisted performance, for children and adults alike.

Some critics suggest that modelling and a genre focus in writing can lead to empty copying of fossilised forms, without engaging students intellect or interest or useful learning taking place (Moskowitz and Kellogg 2011). This is to some extent a valid point, but it depends on what content students are expected to fill their compositions with. In lab or writing classes, where the content is chosen by the teacher, students may have little motivation to move beyond whatever writing models are used. However, in my own ALESS (Active Learning of English for Science Students) writing classes (with Japanese freshman students at the University of Tokyo) students come up with a research question and hypothesis, and design their own basic experiment to test it. This provides them with authentic content of their own. Students are able to adapt features they have noticed (or been guided to notice) in models to describe, explain, and justify their own research. Jones and Freeman (2003, 170) describe this kind of 'copying' process as moving ideally from bootstrapping to calquing and then to autonomous composition. Such a strategy can be used not only with freshmen science students, but can be adapted for use with other age groups and language levels.

Freshman science students lack in-depth knowledge of a specific field, as well as experience in personal research and formal academic and scientific writing (in English or Japanese). Few of them have read formal science papers in Japanese, let alone in English. For this reason, I considered it important to provide models that are not only suitable for teaching the desired rhetorical and linguistic features and paper-writing skills, but that would also be accessible and interesting. The models had to function as 'scientific models' as well as linguistic models; examples that would help students with devising, describing, and explaining their own experiments. Other course developers and teachers have faced similar issues in planning courses on scientific writing, and, as with the approach described by Levis and Levis (2003), I offer students a choice of pre-selected papers to base their own experiments on, as well as selecting suitable papers for whole class work. The papers selected by each student are perhaps the key models in a self-study sense – the student will work with the paper over the course of thirteen weeks and become familiar with its language, graphical features, and scientific content.

This paper takes a practitioner-oriented approach to models and modelling, and describes how and why authentic, teacher-composed, and student models are deployed in my own ALESS Program science writing classes. Appendix 1 outlines the use of models through a thirteen-week science writing syllabus and can be referred to as the paper is read. I begin by describing how models are used to introduce genre, register, and some of the rhetorical features of formal science writing. After that, I show how models are used to help students grasp the structure and organisation of AIMRaD papers and the connection between content, language, and structure, and how to write a summary for a literature review. Thirdly, teacher-composed models are examined in relation to writing a research proposal. Then I outline ways of modelling the part-genres, results sections and abstracts, and also discuss the use of the teacher's voice as a model. Finally I present a method for modelling and composing scientific posters.

It is hoped that the reader can become more familiar with how a scientific writing class can proceed through the use of models, and will be able to apply the ideas presented to other contexts of teaching and learning.

1. Introducing genre and formal writing with authentic models

Students may be familiar with the idea of genre from their experience of films and music, but their explicit knowledge of writing and text genre and practice of genre writing may be rudimentary. This knowledge, and the ability to deploy it actively, is an essential part of being able to write an AIMRaD paper in a style that is appropriate. This can be a challenge when students are largely unfamiliar with formal science writing – even in their native language.

Simple models can be used to introduce students to the scientific writing genres (ie popular and formal), as well as to the types of content that scientific writing contains, its register and other features. A typical exercise for a beginning class makes use of Texts A and B (**Box 1**). Text A comes from a popular wildlife magazine, and is reporting on recent scientific research about crow behaviour (the 'crow papers'). Text B is the abstract from the original paper, which text A is reporting on.

Box 1: Texts A and B used to introduce genre (Lesson 1) (numbers in brackets = sentences).

Text A

Never cross a crow By David Brian Butvil

Do crows have a photographic memory for human faces?

(1) If you know what's good for you, you won't mess with an American crow *Corvus brachyrhyncos*. (2) New research suggests that, after a meaningful interaction, these famously crafty little devils do not forget a human face.
(3) Pets and even lab animals have been shown to recognize people with whom they spend a lot of time. (4) But what about those wilder creatures that probably cross paths with the same person only a handful of times in their lives, at the most?
(5) A team of researchers led by John Marzluff from the University of Washington found out the hard way, by studying crows. (6) Donning rubber masks with a range of human faces, they gave small flocks in various Seattle suburbs a serious scare. (7) The scientists sneaked up on the most distracted individual and tossed a net over it. (8) Then they extracted the bird, slipped a sock over its head (to confine it and keep it calm) and fitted it with a leg band – all the while its nervous flock-mates watched from a safe distance. (9) Then the cawing captive was set free.
(10) This ruffled more than a few feathers. (11) For the next three years, affected flocks scolded and mobbed the masked men and women when they visited – even picking them out from a crowd.
(12) In fact, the crows harassed anyone who put the disguises on, no matter his or her height, body shape or style of walking. (13) Yet they

ignored these same people, including the real trappers, when they did not use the masks or when they wore slightly different ones. (14) This proved that the birds – abductees and witnesses alike – had memorized the face of each trapper after one brief, albeit dramatic, encounter.
(15) So, American crows can instantly memorise human faces and distinguish Joe from Jim, perhaps forever.
(16) Such street-smarts may enable the opportunists to identify foes and friends at a glance, and from a distance.
(17) Indeed, this may be particularly important for an animal that lives in such proximity to humans, a species that is equally likely to toss peanuts as it is to throw stones. (357 words)

[Butvil, D. B. (2010). 'Never cross a crow.' *BBC Wildlife Magazine* 28: 42.]

Text B

Lasting recognition of threatening people by wild American crows

By John M. Marzluff, Jeff Walls, Heather N. Cornell, John C. Whithey, and David P. Craig

(1) While many domestic and laboratory animals recognize familiar humans, such ability in wild animals is only anecdotally known. (2) Here we demonstrate experimentally that a cognitively advanced, social bird, the American crow, *Corvus brachyrhyncos*, quickly and accurately learns to recognize the face of a dangerous person and continues to do so for at least 2.7 years. (3) We exposed wild crows to a novel 'dangerous face' by wearing a unique face mask as we trapped, banded and released 7–15 birds at five sites near Seattle, WA, U.S.A. (4) After trapping, crows consistently used harsh vocalizations to scold and mob people of different sizes, ages, genders and walking gaits who wore the dangerous mask, even when they were in crowds. (5) In contrast, prior to trapping, few crows scolded trappers who wore the dangerous mask. (6) Furthermore, after trapping, few crows scolded trappers who wore no mask or who wore a mask that had not been worn during trapping. (7) In a fully crossed, balanced experiment in which each site had a unique trapping (dangerous) mask and five neutral masks, crows scolded and mobbed a mask more times when it was a dangerous mask at that site than when it was a neutral mask at another site. (8) When simultaneously presented with a person in the dangerous mask and a person in the neutral mask, crows typically ignored the neutral mask and followed and scolded the person wearing the dangerous mask. (9) Risky, aggressive scolding by crows was sensitive to variable costs across study sites; aggression was less where people persecuted crows most. (10) We suggest that conditioned and observational learning of specific threats may allow local bird

behaviours to include aversions to individual people. (285 words)

[Marzluff, J. M. *et al.* (2010). 'Lasting recognition of threatening people by wild American crows.' *Animal Behaviour* 79: 699–707.]

Figure 1: Experimental method from Marzluff *et al.* 2010.

Before approaching the texts themselves, it is helpful to begin with a warm-up exercise to prime students' ideas and vocabulary. I have found the following effective.

Students identify crows from a picture projected on the overhead camera (OHC) and think about what is special about them – whether they like them, how many there are on the campus, what kind of behaviours they display, and so on. Typical answers include comments about crows eating rubbish or bothering people; some students comment about crows' intelligence. A second picture, from the research paper (Figure 1), is then shown, and students are asked what the researchers might have used the materials to research – in other words 'what was their aim?' Aims and research questions can be noted on the board, and keywords elicited from students often include 'memorise', 'recognise' and 'distinguish', which are useful words and concepts to highlight before reading the texts. The warmer acts as a useful pre-reading task, and students are intrigued by the seemingly banal questions about crows, and then the unusual masks from the research paper.

After the warmer, in the first task (**Box 2**), students are asked to perform a scanning task in which they search for basic key content. They use both texts and locate information about the aim, the method, the result, and the significance of the findings. Finally they consider which text was easier to read and which was harder and why. Students work in pairs, sharing a worksheet in order to encourage discussion and so that each student has support – the teacher monitors and helps as appropriate. Answers are elicited and written up on the board, alongside the more formal terms – aim, method, etc. At this time, we can note that the texts contain largely the same information, though Text A focuses on method, which can be narrated as a story as befits a popular article, while Text B focuses more on results, which is more appropriate for fellow researchers.

Box 2: Tasks used with Texts A and B (Lesson 1).

Task 1 Use texts A and B to answer the questions. You don't need to understand every word of each text, so try not to use a dictionary when you read it first. Note down the numbers of the sentences where you found your answers.

1. What were the researchers trying to find out?
2. How did they do it?
3. What did they find out?
4. Why is the research important/what is important about the findings?
5. Which text was easier to read? Which was more detailed?

Task 2 Now, discuss the following questions in a small group
1. What was the purpose of each text – what kind of people wrote them (author) and who would read them (audience)?
2. Where would you be able to read these texts?
3. What features of the texts helped you decide the audience (for example, writing style/words/information)?

Task 3 Underline any examples of informal writing style you found in Text A.

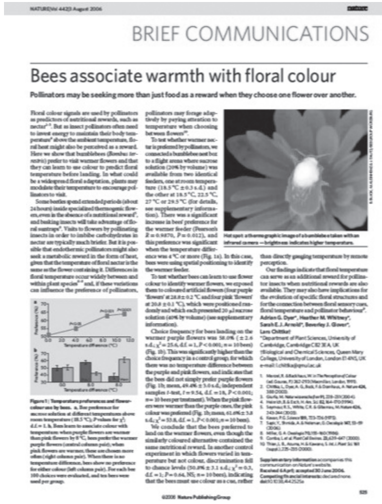
The question of ease of reading depends on the experiences and preferences of each student. Most though choose Text A, commenting that it is broken up into short paragraphs, and that the language is easier – it has more, but 'easier' words, with which they are more familiar, and these are written in shorter sentences. A few choose Text B. Text B is clearly more detailed, which students recognise. Task 2 involves thinking about and discussing the purpose and audience of each text, with Text A being entertaining and informative and less formal, for the general reader, and Text B giving precise information, being more formal, and likely to be for specialists. At this stage, the original magazine and research paper can be passed around, allowing students to see the different contexts, layouts, and design features that accompany the texts.

The final task with these two texts aims at focussing students' attention on features of register. Students, now familiar with both texts, are asked to underline informal features of Text A – they usually work in pairs. For starting off, the text can be shown on the OHC and an example given – for example, the first two sentences contain 'you' indicating an informal 'oral style' of address to the reader, contractions, and a multi-word verb. Sentence two contains an idiomatic and fun expression 'crafty little devils'. Given time, students can identify the many informal features, and depending on their English experience, underline varying amounts of text. During the task, the teacher is able to monitor and help and take part in students' discussions. An OHC can be used to highlight and discuss the various examples, and/or students can swap their marked up papers around to examine peers' work. This marking up is also preparation for the kind of peer editing students will do in later classes with each other's writing.

As can be seen, the two texts are multi-purpose models, and examining and noticing features is an effective way of introducing students to both formal and informal science writing. These tasks can be simply adapted for students of different ages, language abilities, and interests. After using models to introduce ideas about genre and content, further models can be deployed to examine the organisation and special features of AIMRaD papers.

2. Introducing the IMRD paper and its organisation

The *Brevia* papers that appear in *Science* and *Brief Communications* papers that appeared in *Nature* can perform as useful models for examining the structure, organisation and rhetorical features of IMRD papers (Allen and Middleton 2010). These papers are short, typically a single page, and address a variety of subjects intended to be of wide appeal (Figure 2). They typically do not employ subheadings to distinguish sections, which allows them


BRIEF COMMUNICATIONS

Bees associate warmth with floral colour

Pollinators may be seeking more than just food as a reward when they choose one flower over another.

Figure 2: Example of a 'Brief Communications' paper from Nature (Dyer et al. 2006).

to be easily used in their original form for exploring structure and organisation through rhetorical features. Successfully dealing with a manageable sized paper can increase students' confidence and aid them in conceiving of their own experiment and writing their papers.

One paper used in class is about bees and floral colour ('the bee paper') (Dyer *et al*. 2006)[1]. The attractive colour graphic (Figure 2) can be used as a warmer for this paper – students can be asked what it is (it is a thermographic image of a bee on a flower) and introduced briefly to Greco-Latin scientific terminology: 'thermo' = heat 'graphic' = picture, as well as the style of the title and the topic of the paper. Task 1 involves finding some key information necessary for writing a reference and usually found on the first page of an article (Box 3). This task is straightforward, but promotes discussion of references, effective titles, and of audience. It also gives students a chance to explore the paper in their own time, without having to read it through and comprehend it – total comprehension is not necessary in order to use models, which makes the use of authentic models possible at different levels of language ability ('grade the task not the model'). During feedback, a reference can be written item by item on the board, and students can be taught how papers are referred to orally – 'let's call this paper Dyer et al. 2006'.

Box 3: Getting to know an IMRD paper (Lesson 2).

Task 1 Look at the short research paper and discuss the following questions.

1. Who wrote the paper (the **authors**)?
2. What's the **title** of the paper?
3. When was it **published (date)**?
4. What is the name of the **journal**?

You need this information for writing a **reference** (see 'Citations and references' in the *ALESS Companion* pp. 26–27 and university booklet).

Example reference:
Fang, Z. (2005). 'Scientific literacy: A systemic functional linguistics perspective.' *Science Education* 89(2): 335–347.

Task 2 The paper probably looks very different from novels and magazine articles that you have read before. With your partner, note some of the differences below. Number one is given as an example.

1. A list of **references** at the end
2. ______________________________
3. ______________________________
4. ______________________________

- Why does the paper include the items you listed in Task 2?
- Do you 'trust' the paper? Why/why not?

The second task involves noticing genre features, as students are asked to consider what features make this text look different from a novel, magazine article, or comic book etc and their purpose (Box 3); it reinforces the idea of genre that students were previously introduced to. Using the OHC, the list of references can be pointed out as an example. Students will need to include a list of references in their own papers, so thinking about them early on is useful. Astute students will notice that the superscript numbers in the text correspond to the references at the end.

Students notice (and their attention can also be drawn to) author information, a contact email address, figures, numerical data, three columns of small print, doi, and so on. All of these may be elicited by going around the class asking each pair to volunteer an item and to try to explain its purpose. The teacher can use an OHC or other visual tool to zoom in on the features noticed. Gaps in knowledge can be filled in by other students or the teacher, if they cannot be elicited. A final discussion point focuses on the issue of 'trust' ('do you trust this paper – why/why not?) and allows discussion of how AIMRaD papers seek to persuade through features of openness.

These introductions to the genre of AIMRaD using authentic models can lead into a more involved engagement with a short paper. None of the tasks described require a high level of reading comprehension and the tasks can help students to become more confident in reading and discussing texts and to prepare for writing their own paper.

Organisation and language with an authentic AIMRaD paper

AIMRaD papers are accessible target products for student writing in part because of their regular and formulaic structure. Even when papers deviate from abstract > introduction > methods > results > discussion, each section is present in some form, whatever the order (it is not unusual now to find methods placed at the end of a paper). This means that knowledge of the structural features of an AIMRaD paper can be easily acquired by students.

In class, the bee paper (or whichever paper is deemed suitable by the teacher) can be further used. Tasks 3 and 4 involve scanning the text for particular features, some of which have already been noticed by students, and then assigning section headings to then (Box 4; Appendix 2). Students may need to be reminded of the meaning of the headings, which were introduced in the previous class (Box 2, Task 1). They may also use dictionaries, ask each other or the teacher, but many can work out the organisation logically. Students work together to note the paragraphs where they find each section. Again, at this stage, little reading comprehension is necessary because formulaic language offers a key; this makes the exercise and text accessible to students of all levels.

Box 4: Tasks to map the IMRD paper (Lesson 2).

Task 3 Using Text 1, answer the following questions. You don't need to read the text.

a) In which paragraphs did you find **citation numbers**?
b) Which paragraphs use more **past tense** verbs?
c) Where did you see **personal pronouns** like 'I/we/us/our'?
d) Did you see **numerical data** in the text? Where?
e) In which paragraphs did you see mainly **modals** (e.g. may/could) and **present tense** verbs?

Task 4 With your partner, **label** each **section** of the paper using the **sub-headings** in the **table** below. One paragraph may contain two sections; some sections occur twice. You can use the ***Companion*** to check the meaning of the headings.

Results (x 2)	Discussion	Introduction	Methods (x 2)	Abstract

Do you notice any relationship between the language features in Task 3 and the organization of the paper?

Tasks 3 and 4 result in a 'map' of the AIMRaD paper which can be drawn up on the board as students give answers to each question (Box 5). Mapping the 'bee paper' includes an extra challenge, since there are in fact two methods and two results sections – one paragraph incorporates one of each. It is useful to note personal pronoun use and use of active and passive voice.

Box 5: 'Map' of the IMRD paper (see also Appendix).

Paragraph	Citation numbers	Past tense verbs	Personal pronouns	Numerical data	Modals / present tense verbs	Section of paper
1	Yes (unusual)	Yes	Yes ('Here we show')	No	Yes (could/may)	**Abstract / summary**
2	Yes	No	No (facts/hypothesis)	No	Yes (possible/if/can/may)	**Introduction**
3	No	Yes	Yes ('To test... we...') No, (permissible) but passive voice used instead	Yes	No	**Methods** **Results**
4	No	Yes	Yes ('To test... we...')	Yes	No	**Methods**
5	No	Yes	No	Yes	No	**Results**

6	Yes	Yes (only to report own results)	Yes ('We conclude')	Yes (but few)	Yes (may)	**Discussion**
7						

We have looked at how the bee paper is used as a model of the whole of an AIMRaD paper. In later weeks, as students are performing their experiments, I use another model paper, the 'tea paper' (Ven Het Hof *et al*. 1998), to study each section in more depth, reinforcing the points made in these initial two lessons. That paper is adapted slightly for length in places, and presented section by section, but the language is not modified. Students are also given access to previous students' work through the *ALESS Collection*, in which selected student essays are published every semester. Students are free to read any or all of the papers, while the teacher may refer to specific examples, either whole papers or sections of them, that provide good models. For the difficult discussion section, the use of student-composed models has proved particularly effective at teaching the rhetorical content and organization of these sections, aiding students in conceptualising, organizing, and writing their own discussion sections.

Modelling a summary with teacher-composed models

In addition to authentic published paper models used in classes, teacher-produced models are made for specific purposes. One such example is 'the summary', the purpose of which is to enable students to write a very basic literature review for their research proposal, and for the introduction of their paper – summarising a background paper from which their own experiment and research project derives. The literature review is a key part-genre of most research writing; having students choose a single background paper and base their own experiment on it allows the student to act as a *bona fide* researcher or 'expert' situated with genuine field-specific knowledge.

The exercise in Box 6 integrates authentic and teacher-produced models and materials. Students are first provided with a graphic abstract made by the teacher, which includes title, reference information, and abstract, as well as graphics from the method and results sections. Students are given some time to examine it before starting Task 1; they are encouraged to notice just how much useful information can be gleaned from such information, which encourages 'strategic' reading. Task 1 involves completing a simple cloze to complete a basic summary of a research paper. The follow up task requires students again to identify the key information included in the summary (the hypothesis, variables, methods etc), as in the first lesson tasks using the 'crow papers'.

Box 6: Modelling a summary (Lesson 3).

Task 1 Use the abstract and graphics of Hirota et al.'s paper. Complete the basic summary using the words in the box below.

Hirota et al. studied the effect of 1) ____________ on the 2) ____________ and growth of cucumber plants by 3) ____________ to fields of different strengths.[1] They found that the 4) ____________ of cucumbers is affected when they are germinated under the influence of a magnetic field. The effect 5) ____________ with the strength of the field. This is important because it shows the influence of magnetic fields on 6) ____________ in living bodies.

Reference

1. Hirota, N., Nakagawa, J. and Kitazawa, K. (1999). 'Effects of a magnetic field on the germination of plants.' *Journal of Applied Physics* 85: 5717–5719.

growth direction   germination   exposing seeds
magnetic fields   biological processes   varied

Notice that a summary might include these key points: **aim** / independent & dependent **variables** / **subject** / **method** / **result** / **importance** of a particular background paper.

What follows this task is somewhat more challenging. By this time, students have each chosen a background paper from a selection provided, and, having worked with the model, they are asked to use the same method to write their own summaries, which they will also present orally to each other. Typically students are asked to choose several background papers, so that they can use the one they understand best in this task. Given time and careful monitoring, the teacher is able to help those students who have difficulty with this. Very often, graphics from the results section can be helpful in identifying key information such as variables and subject, whilst the abstract should include all the necessary information, albeit possibly written in 'difficult' language. By writing and presenting summaries to each other, students can also be encouraged to check that all the key information has been identified, and can help each other to find it if it has not been found.

Although this task has a language-learning purpose, it also serves to help students to develop their experiment ideas with reference to their background paper. Next, students complete a basic outline research proposal form, which incorporates a reference and a summary as the basis of their new research (Appendix 3). This also builds on the earlier model-driven tasks in which key information and concepts such as variables and method were discussed. Again a teacher-produced model is provided, one based on 'authentic' research proposal outlines, and discussed in class; students complete their own proposal at home for peer discussion later. After that, students are presented with a written research proposal.

3. The written research proposal

The outline proposal form is reviewed by students in groups, with a view to checking that the experiment plan itself is safe and workable – it is an authentic working document in its own right, not merely a 'mock' proposal. Following this discussion phase, students are encouraged to think more about their proposal and to incorporate peer feedback into their research idea. The second stage (Lesson 4) involves writing up the research proposal in the form of a written proposal document, which is presented to class and also submitted as assessed work. Again a teacher-written model, specific and appropriate to the course, is used (Appendix 4). It builds on the outline proposal, which serves in this way as a pre-writing task. The written proposal comprises two sections, an introduction and method section, with a single reference to the published background paper a student has chosen.

The introduction of the model is based on Swales (2004) 'create a research space' (CARS) moves for the introduction, in which the area of the study is mapped out by reference to previous work, a fact, gap, and hypothesis are introduced, the importance/relevance of the study is stated (Box 7). The method section describes actions to be taken to test the hypothesis and consists mainly of description and justification. One advantage of writing up the research proposal is that it allows students to pre-draft half of their research paper – the proposal can form the basis of the paper to follow. The fact that many proposals quite formulaically follow the model in its structure is not deemed a problem or considered mere imitation. The proposal remains an authentic working document, and the paper, written over subsequent weeks, may change dramatically from the initial proposal (not only in features such as tense).

Box 7: Swales revised 'create a research space' (CARS) model (after Swales 2004).

Move 1. Establishing a territory (citations required) via
Topic generalizations of increasing specificity

Move 2. Establishing a niche (citations possible) via
Step 1A Indicating a gap, or
Step 1B Adding to what is known
Step 2 (optional) Presenting positive justification

Move 3. Presenting the present work (citations possible)
Step 1 (obligatory) Announcing present research descriptively and/or purposively
Step 2* (optional) Presenting research questions or hypotheses
Step 3 (optional) Definitional clarifications
Step 4 (optional) Summarizing methods
Step 5 (PISF**) Announcing principal outcomes
Step 6 (PISF) Stating the value of the present research
Step 7 (PISF) Outlining the structure of the paper.

* Steps 2–4 are not only optional but less fixed in their order of occurrence than the others
** PISF: Probable in some fields, but unlikely in others

4. Modelling part-genres

Graphics, teacher talk, and the results section

Modelling should not only be considered in relation to textual

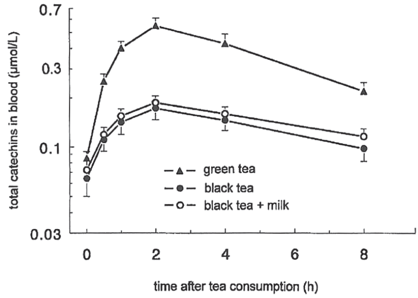


Figure 1 Total catechin concentration in blood after consumption of green tea, black tea or black tea with milk. Data represent mean ± CVM ($n = 12$).

Figure 3: Results figure 1 from Ven Het Hof 1998.

investigation and composition practice. Lemke (1990) notes that doing science is 'talking science' and in science writing classes students can be expected to do and to talk about science, as well as to discuss, evaluate, and review their own scientific writing in the context of the models they have worked with. Such talk is also part of their apprenticeship into a global scientific community that frequently works in English (Duff 2010).

Although the call to minimise teacher talk time and maximise student talk time is traditional in EFL circles, the teacher's voice can provide an important model for demonstrating language of a particular register, for conveying appropriate lexis, pronunciation and rhetorical moves (Cullen 1998). Teacher talk is not used only to convey task instructions or answers, or to elicit, encourage, or motivate.

An example of teacher talk as a model can be given from a lesson (Lesson 8) when the results section of a research paper is explored. Students, who have analysed the introduction and method section of the paper already (which is Ven Het Hof 1998, the 'tea paper') first look at three graphics (Figure 3) from the results section in pairs, describing the information and then writing sentences for an imaginary results section with question prompts modelling reporting verbs and methods of referring to graphics in sentences (explicitly 'figure 1 shows' or using brackets at the end of the sentence). Feeding back on this task allows not only checking of answers but a model of how to describe a figure.

For example, the teacher may first elicit information from the students about the figure, based on their examination of the results section figures. In summary, he may then say (whilst gesturing appropriately towards the figure, which is projected via OHC) something like:

> Figure 1 shows the total catechin concentration in blood after consumption of three tea samples. The 'x' axis shows the time after tea consumption in hours and the 'y' axis shows the total catechin concentration in blood in micromoles per litre. The black triangle indicates green tea etc. This line shows the transition of catechins in the blood over time after drinking green tea. The concentration increases at first and the time to maximum concentration is two hours. At maximum concentration, catechin concentration in blood after drinking green tea is approximately three times that of black tea and black tea with milk. There is no significant difference in catechin concentration in blood after drinking black tea and black tea with milk, which suggests that the hypothesis is not correct.

Through the register, lexis, gesture, and manner of delivery, the teacher is able to model formal scientific English suitable for a written text and also to demonstrate formal presentation language and style – students, as well as writing a paper, perform a five minute presentation of their research at the end of the course. Thus vocal modelling can be at least as important as textual modelling, and in addition provides an alternative vehicle for teaching scientific communication spoken and written.

The abstract

During weeks six to eight of the class, a paper about the effect of milk on tea catechins is used to investigate each part-genre of the paper (Ven Het Hof 1998, the 'tea paper'). By lesson nine, students have drafted their paper in sections (introduction and methods, the results and discussion), reviewed, and redrafted their papers several times after exploring the models presented, and now must write the abstract. In lesson 9, students are given three abstracts to examine, from papers/subjects they are now familiar with (the 'crow', 'bee', and 'tea' papers). Using very simple questions (e.g. which abstracts have keywords?), they explore the features of the three different kinds of abstract – a structured abstract, a standard (non-structured) abstract, and the first paragraph from a *Brief Communications* paper, which combines features of abstract and introduction (Allen and Middleton 2010; Squires 1990).

Box 8: Three types of abstract.

Objectives: To assess the blood concentrations of catechins following green or black tea ingestion and the effect of addition of milk to black tea.
Design: Twelve volunteers received a single dose of green tea, black tea and black tea with milk in a randomized cross-over design with one-week intervals. Blood samples were drawn before and up to eight hours after tea consumption.
Setting: The study was performed at the Unilever Research Vlaardingen in The Netherlands.
Subjects: Twelve healthy adult volunteers (7 females, 5 males) participated in the study. They were recruited among employees of Unilever Research Vlaardingen.
Interventions: Green tea, black tea and black tea with semi-skimmed milk (3 g tea solids each).
Results: Consumption of green tea (0.9 g total catechins) or black tea (0.3 g total catechins) resulted in a rapid increase of catechins levels in blood with an average maximum change from baseline (CVM (of 0.46 μmol/l (13%) after ingestion of green tea and 0.10 μmol/l (13%) in case of black tea. These maximum changes were reached after (mean (s.e.m.)) $t = 2.3$ h (0.2) and $t = 2.2$ h (0.2) for green and black tea respectively. Blood levels rapidly declined with an elimination rate (mean CVM) of $t_{1/2} = 4.8$ h (5%) for green tea and $t_{1/2} = 6.9$ h (8%) for black tea. Addition of milk to black tea (100 ml) did not significantly affect the blood catechins levels (areas under the curves (mean (CVM) of 0.53 h. μmol/l (11%) vs 0.60 h. μmol/l (9%) for black tea and black tea with milk respectively.
Conclusion: Catechins from green tea and black tea are rapidly absorbed and milk does not impair the bioavailabilty of tea catechins.
Descriptors: bioavailability; flavonoids; catechins; tea; milk; human study

[Ven het Hof, K. H., Kivits, G. A. A., Westrate, J. A. and Tijburg, L. B. M. (1998) 'Bioavailability of catechins from tea: the effect of milk.' *European Journal of Clinical Nutrition* 52, 356–359.]

While many domestic and laboratory animals recognize familiar humans, such ability in wild animals is only anecdotally known. Here we demonstrate experimentally that a cognitively advanced, social bird, the American crow, *Corvus brachyrhyncos*, quickly and accurately learns to recognize the face of a dangerous person and continues to do so for at least 2.7 years. We exposed wild crows to a novel 'dangerous face' by wearing a unique face mask as we trapped, banded and released 7–15 birds at five sites near Seattle, WA, U.S.A. After trapping, crows consistently used harsh vocalizations to scold and mob people of different sizes, ages, genders and walking gaits who wore the dangerous mask, even when they were in crowds. In contrast, prior to trapping, few crows scolded trappers who wore the dangerous mask. Furthermore, after trapping, few crows scolded trappers who wore no mask or who wore a mask that had not been worn during trapping. In a fully crossed, balanced experiment in which each site had a unique trapping (dangerous) mask and five neutral masks, crows scolded and mobbed a mask more times when it was a dangerous mask at that site than when it was a neutral mask at another site. When simultaneously presented with a person in the dangerous mask and a person in the neutral mask, crows typically ignored the neutral mask and followed and scolded the person wearing the dangerous mask. Risky, aggressive scolding by crows was sensitive to variable costs across study sites; aggression was less where people persecuted crows most. We suggest that conditioned and observational learning of specific threats may allow local bird behaviours to include aversions to individual people.

Keywords: American crow; Corvus brachyrhynchos; ecologically relevant conditioned response; individual recognition; learning; memory; mobbing; recognition of humans; scolding

[Marzluff, J. M., Walls, J., Cornell, H. N., Withey, J. C. and Craig, D. P. (2010). 'Lasting recognition of threatening people by wild American crows.' *Animal Behaviour* 79, 699–707.]

Floral colour signals are used by pollinators as predictors of nutritional rewards, such as nectar[1–3]. But as insect pollinators often need to invest energy to maintain their body temperature[4] above the ambient temperature, floral heat might also be perceived as a reward. Here we show that bumblebees (*Bombus terrestris*) prefer to visit warmer flowers and that they can learn to use colour to predict floral temperature before landing. In what could be a widespread floral adaptation, plants may modulate their temperature to encourage pollinators to visit.

[Dyer, A. G. *et al*. (2006). 'Bees associate warmth with floral colour.' *Nature* 442: 525.]

The three abstracts are discussed with reference to information types and quality, as well as audience. For example, the purpose of keywords is considered, as is the amount of method versus results information, and the form and reasons for using structured versus non-structured abstract. Students are then asked to choose a type of abstract to write, bearing in mind that their audience (fellow students and teachers) are likely not experts in their field, and to write an abstract in twenty to thirty minutes in class. Students are encouraged to note that abstracts summarise information from each part of the AIMRaD paper, often following a pattern of fact > gap > conclusion > importance; in addition we note useful 'standard' phrases such as 'here we show'. As can be seen from the student example (Box 9), students can choose a suitable style and write abstracts with the requisite information and in a formal register.

Box 9: A student abstract.

> A granular pile of uniform material has a specific angle of inclination known as the angle of repose. However, the angle of repose for a granular mixture was unknown. I prepared mixtures consisting of two materials to uncover the relationship between mixture ratio and the angle of repose. It was found that the angle of repose is in a linear relationship with mixture ratio. This study helps to understand the mechanism of avalanches and mudslides from a statistical viewpoint. It remains unclear what exactly contributes to difference in angle of repose for each material.
>
> Keywords: granular pile; mixture; inclination; angle of repose
>
> [Kuroki, S. (2013). 'Inclination angle of binary granular piles.' *ALESS Collection* 6]

5. Scientific posters

A final model employed in my ALESS classes is the scientific poster (Lesson 7). Posters are used by researchers, scientists, and others to convey the results of research (Block 1996; Matthews 1990). The genre is therefore an important one for students to be aware of and to practice. In addition, the poster is an essential prop in students' own five-minute presentations, providing notes and visual cues to aid presentation and audience comprehension.

The model used here is a teacher-produced model based on

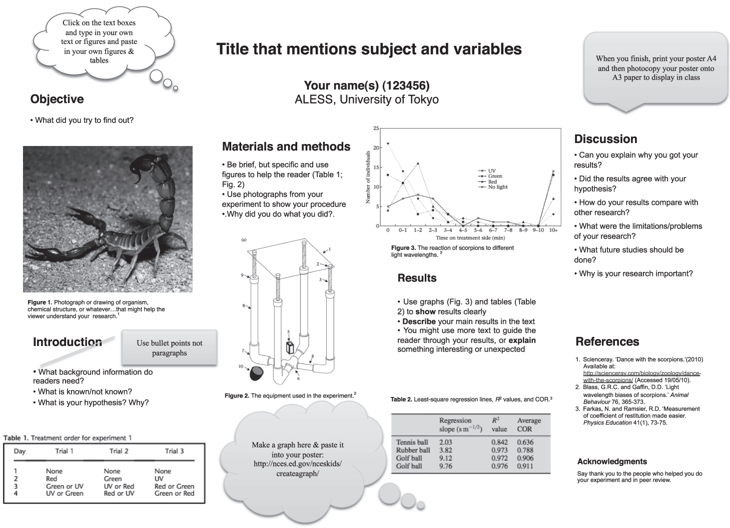


Figure 4: Model & template of a scientific poster.

authentic samples of scientific posters from poster sessions (Figure 4). It closely resembles an AIMRaD paper in basic structure and is written in a form, if in an abbreviated 'bullet-point' style. Since students already have plenty to do in their 13-week ALESS Program, a PowerPoint poster template is made available for them to download and adapt to their own needs and tastes. Each section of the template contains hints and tips on how to fill it in, making it an easy-to-use self-study resource. The aim is to use the poster as a tool for presentation, and therefore this task is made as straightforward as possible. The provision of a template allows students less experienced with PowerPoint or graphics to make a serviceable and effective poster easily. The model scaffolds students' own original poster.

Conclusion

This paper has described the importance of modelling in the teaching of the AIMRaD paper in the ALESS Program, has described the use and value of authentic and teacher-composed models, and explained some of the ways in which models can be used. It also outlined the use of teacher talk as a model for both writing and presentation. Models can be used both in teaching tasks and as self-access resources in ways that promote autonomous learning.

Although the ALESS Program at the University of Tokyo is delivered to first year science students who are highly able (if lacking in active use of English), a model-based approach is suitable at other levels and in other contexts too, and the basic procedures outlined above can be adapted for use at different age-groups and levels of scientific and linguistics ability and motivation. Once a program has started, student-based models can be developed to support the use of other models, which can add an important sense of task achievability, even of competitive motivation to 'outdo' the model.

Notes

1. Other papers used include: Behringer, D. C., Butler, M. J. & Shields, J. D. (2006). 'Avoidance of disease by social lobsters.' *Nature* 441: 421 and Hill, R. A. & Barton, R. A. (2005). 'Red enhances human performance in contests.' *Nature* 435: 293.

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Appendix 1 Models used by lesson in the 13-week science writing class*

Lesson	Aim of model use	Model text used for input	Experiment and Paper stages
1	• To introduce genre, purpose, audience, register and key scientific content (aims, methods, results, discussion)	'Crow papers' from *BBC Wildlife Magazine* (Butvil 2010) and *Animal Behaviour* (Marzluff, J. M. *et al*. 2010).	Introduction to course
2	• To introduce referencing information, citations, and the structure and organization of IMRD papers. • To observe the connection between linguistic features, content, and function	'Bee paper' from Nature (Dyer, A. G. *et al.* 2006).	Choosing a topic area from a collection of published background papers
3	• To introduce summary writing for the literature review • To aid students in developing new research questions from previous literature	Students chosen published example papers + teacher-composed model summary & research proposal form	Complete a basic research proposal form with a summary and reference + peer feedback
4	• To aid students develop their proposals further after feedback and to pre-write an introduction and method section	Teacher-composed written research proposal summary	Complete a written research summary (introduction and methods) + peer feedback
5	• To scaffold students first oral presentation	See week 4	Present the written proposal to class and receive feedback + start the experiment
6	• To note content of typical introductions, including background, definitions/explanations, fact, gap, hypothesis, and summary of research • To examine the method section, its organization, lexical register, and use of active and passive constructions to describe processes in the method	'Tea paper' introduction and methods sections + 'bee paper' method section	Revise the introduction and methods + continue the experiment

7	• To introduce the scientific poster and observe similarities and differences between it and a paper • To consider the uses of a poster in scientific communication and begin preparing a poster for presentation	Teacher-composed *ALESS scientific poster* template + past student examples	Continue the experiment + begin thinking about poster (download template) + revise introduction and methods
8	• To introduce the content of typical discussion and results section including graphics • To examine previous student papers from the ALESS Collection both for content, organization, and format (also done in later classes in peer editing)	'Tea paper' results and discussion sections + selected examples from student-composed *ALESS Collection papers* [Oral model of graphics description by teacher] *ALESS Collection* papers	Complete the experiment. Draft results and discussion (these are peer reviewed and revised in the following weeks)
9	• To demonstrate three types of abstract and for students to write the abstract in class	'Tea', 'Bee' and 'Crow' paper abstracts (representing different styles) Teacher-composed poster template + past student examples	Write the abstract last

* Week 10 is a poster class, weeks 11, and 12 are presentation classes; week 13 is for feedback and reflection.

Appendix 2 – Text of Dyer, A. G. *et al*. (2006). 'Bees associate warmth with floral colour.' *Nature* 442: 505.

	Bees associate warmth with floral colour
1 Abstract	Floral colour signals are used by pollinators as predictors of nutritional rewards, such as nectar[1–3]. But as insect pollinators often need to invest energy to maintain their body temperature[4] above the ambient temperature, floral heat might also be perceived as a reward. Here we show that bumblebees (*Bombus terrestris*) prefer to visit warmer flowers and that they can learn to use colour to predict floral temperature before landing. In what could be a widespread floral adaptation, plants may modulate their temperature to encourage pollinators to visit.
2 Introduction	Some beetles spend extended periods (about 24 hours) inside specialized thermogenic flowers, even in the absence of a nutritional reward[5], and basking insects will take advantage of floral suntraps[6]. Visits to flowers by pollinating insects in order to imbibe carbohydrates in nectar are typically much briefer. But it is possible that endothermic pollinators might also seek a metabolic reward in the form of heat, given that the temperature of floral nectar is the same as the flower containing it. Differences in floral temperature occur widely between and within plant species[6–9] and, if these variations can influence the preference of pollinators, a pollinators may forage adaptively by paying attention to temperature when choosing between flowers[10].
3 Methods Results	To test whether warmer nectar is preferred by pollinators, we connected a bumblebee nest box to a flight arena where sucrose solution (20% by volume) was available from two identical feeders, one at room temperature (18.5 C ± 0.3 s.d.) and the other at 18.5 °C, 22.5 °C, 27 °C or 29.5 °C (for details, see supplementary information). There was a significant increase in bees' preference for the warmer feeder (Pearson's $R = 0.9870$, $P = 0.012$), and this preference was significant when the temperature difference was 4 °C or more (Fig. 1a). In this case, bees were using spatial positioning to identify the warmer feeder.

4 Methods	To test whether bees can learn to use flower colour to identify warmer flowers, we exposed them to coloured artificial flowers (four purple 'flowers' at 28.8 ± 0.2 °C and four pink 'flowers' at 20.8 ± 0.1 °C), which were positioned randomly and which each presented 20 μl sucrose solution (40% by volume) (see supplementary information).
5 Results	Choice frequency for bees landing on the warmer purple flowers was 58.0% (± 2.6 s.d.; $\chi^2 = 25.6$, d.f = 1, $P<0.001$; $n = 10$ bees). This was significantly higher than the choice frequency in a control group, for which there was no temperature difference between the purple and pink flowers, and indicates that the bees did not simply prefer purple flowers (Fig. 1b; mean, 49.4% ± 3.0 s.d.; independent samples t-test, $t = 9.54$, d.f. = 18, $P<0.001$; $n = 10$ bees per treatment). When the pink flowers were warmer than the purple ones, the pink colour was preferred (Fig. 1b; mean, 61.6% ± 3.8 s.d.; $\chi^2 = 53.8$, d.f. = 1, $P<0.001$; $n = 10$ bees).
6 Discussion	We conclude that the bees preferred to land on the warmer flowers, even though the similarly coloured alternative contained the same nutritional reward. In another control experiment in which flowers varied in temperature but not colour, discrimination fell to chance levels (50.8% ± 3.1 s.d.; $\chi^2 = 0.3$, d.f. = 1; $P = 0.64$, NS; $n = 10$ bees), indicating that the bees must use colour as a cue, rather than directly gauging temperature by remote perception.
7	Our findings indicate that floral temperature can serve as an additional reward for pollinator insects when nutritional rewards are also available. They may also have implications for the evolution of specific floral structures and for the connection between floral sensory cues, floral temperature and pollinator behaviour[9].
Author	Adrian G. Dyer[*], Heather M. Whitney[*], Sarah E. J. Arnold[*], Beverley J. Glover[*], Lars Chittka[†]
information	[*]Department of Plant Sciences, University of Cambridge, Cambridge CB2 3EA, UK [†]Biological and Chemical Sciences, Queen Mary College, University of London, London E1 4NS, UK e-mail: l.chittka@qmul.ac.uk

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Other information	Supplementary information accompanies this communication on Nature's website. Received 6 April; accepted 30 June 2006. Competing financial interests: declared none. doi:10.1038/442525a

Appendix 3 – Research Proposal Form

ALESS Research Proposal Outline (H/W)

Name Guy MIDDLETON

Class (eg Mon 4) Monday 4

Published background paper (write the author / title / journal name and other details)
Clement and Eckardt 'Influence of the gravitational vertical' *Acta Astronautica* 56, 911-917 (2005)

Project Area Visual perception

Title The effect of orientation playing ability in Tetris

Summary from the background paper (summarise the research by reading the abstract and identifying the key information)

Clement and Eckardt studied the effect of orientation on the perception of geometric visual illusions.[1] They found that the orientation of participants (upright, lying on their sides, and supine) caused them to experience some illusions less frequently while the effects of other illusions were delayed. They suggest that this may be due to the importance of gravitational references in the illusions.

Research question / Aim
Does orientation/position affect the ability to play Tetris?

Hypothesis + reason
Orientation affects the ability to see geometric visual illusions. If people play Tetris in different positions, their playing ability might also be affected.

Variables

Independent (what I change) – I will change orientation (upright, side, lying down (supine))

Dependent (what I observe/measure) – Tetris score of each player

Controlled (what I keep the same) – time of day, distance of game from head, order of playing in different positions

Materials (what I need)

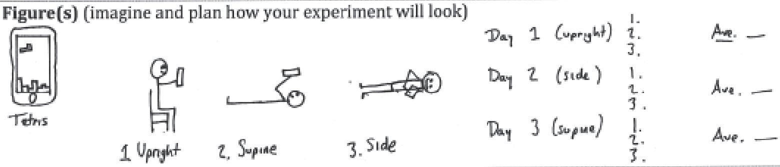
Volunteers
Tetris game (on iPhone)
Play schedule

Methods
Volunteers play 3 games of Tetris per day (= 1 session). Each day they play in a different orientation (upright, side, supine). (Day 1 – upright, Day 2 – left side, Day 3 – supine etc) They record the scores, so I can work out the average. This is done 3 times for each orientation – total 27 games (9 sessions). The volunteers will give me their scores.

What kind of **data** will I get? How will it be **analysed**?
I will get the scores (numbers). I will work out average scores for each orientation and compare them to see if there is a relationship between score and orientation.

How long will the experiment take? About 9/10 days.

Figure(s) (imagine and plan how your experiment will look)



Appendix 4 – Written research proposal example

ALESS Research Proposal Example
Week 4 homework

Orientation and task achievement in a geometric shape game

Introduction
(1) Clement and Eckardt studied the effect of orientation on the perception of geometric visual illusions.[1] (2) They found that the orientation of participants (upright, lying on their sides, and supine) caused them to experience some illusions less frequently while the effects of other illusions were delayed. (3) They suggest that this may be due to the importance of gravitational references in the illusions.

(4) It is important to consider the effects of orientation on visual perception because the safety and abilities of pilots, deep-sea divers, and astronauts may be affected when they are carrying out normal duties. (5) In addition, it also increases understanding of human visual perception.

(6) Studies have shown that orientation may have some effect on the perception of geometric illusions.[1] (7) However, it is not clear whether orientation affects the performance of an active task based on manipulating geometric shapes. (8) If orientation affects perception of geometric illusions, it seems likely that it could also affect this kind of task performance.

(9) In order to research this, I will ask volunteers to play Tetris, a game in which players manipulate falling geometric shapes, in three orientations: an upright position, lying on their sides, and supine. (10) By recording and comparing the scores achieved in different positions, any link between orientation and task achievement should be revealed.

Method
(11) To test whether orientation affects task achievement, I will recruit five volunteers from among ALESS Faculty staff and ask them to play games of Tetris on their iPhones whilst in three positions: upright, lying on their left sides, and supine (lying on the back with face up). (12) The Tetris game is used because it involves the manipulation of geometric shapes falling downwards to the bottom of the screen, which resembles human perception of objects falling to earth. (13) The game will be held in front of the head oriented in the usual way relative to the head, and at a distance of 50–60 cm. (14) Participants will be asked to keep the room dark and quiet so as to minimize distractions.

(15) Volunteers will be asked to play three games in a row every day for nine days, each day playing in a different position. (16) This is because if they only play in each position one time, their skill may improve with each game, and this would affect the results. (17) They will record their scores in a table I give them. (18) The playing schedule will be the same for each participant, which will also increase the reliability of the results. (19) By examining the scores obtained at each position for each player, and plotting them on a graph, I should be able to observe whether orientation has any effect on playing ability.

References

1. Clement, G. and Eckardt, J. 'Influence of the gravitational vertical on geometric visual illusions.' *Acta Astronautica* 56, 911–917 (2005).