# Writing to Learn: Designing Interactive Learning Environments to Promote Engagement in Learning Through Writing

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**Abstract**

*This paper discusses the design and purpose of an interactive learning environment (ILE) used at university for writing to learn. Writing to learn is a strategy that lecturers can employ to encourage student engagement in learning. This strategy has been used to help students engage with the subject matter in Plant Science and Physiology, an undergraduate first-year science subject. Choosing genre-based literacy pedagogy as the teaching and learning model behind the approach of writing to learn, the lecturers, in collaboration with students, technology providers and applied linguists, designed an interactive learning environment which contains a scientific writing database. The database is used to model the elemental genres of the assessable scientific writing tasks. Supporting the database are a bulletin board and word-processor files which outline modelling and other learning processes. The students use the ILE to assist their writing preparation, process and production. The interactive nature of the ILE facilitates various types of feedback which the students can access. The choice available to the students in the types of feedback and the variety of model texts combine to provide learning processes which are potentially unique for each student. This feature of the ILE improves its potential to meet the individual learning and literacy needs of the students.*

**Key Words**

*Writing to learn, Interactive learning environment, Plant science and physiology, Student-centred*

## Introduction

Faced with students who are not engaging sufficiently with subject content, lecturers are constantly on the lookout for promising strategies for encouraging students to actively participate in learning. One promising strategy is the use of writing to learn (Jackson 1991, Biggs 1993, Taylor and Drury, 1996). Writing to learn refers to the idea that domains of knowledge have their own distinctive forms of language, and that by communicating their understanding in written form, students construct their own understanding of the knowledge. Felicitously, students can also develop higher-order, more generic writing skills, as they engage in such learning (Webb, 1999).

Choosing writing to learn as a strategy for engaging students in the learning process presupposes the adoption of a theoretical framework for the teaching methodology. The framework chosen for this case study is genre-based literacy pedagogy (Martin, 1999). The teaching and learning model from this pedagogy was chosen because it promotes control of genre and register, a strategy which the lecturers felt would best meet the demonstrated needs of the students. The pedagogy foregrounds the use of model texts. Model texts are a fruitful learning resource which, when taken from student-produced texts, provide a realistic identifiable goal to which the students may strive.

The benefits of a monolithic learning environment (WebCT) and a word-processor (Microsoft Word) have been used to develop an interactive online learning environment. The combination of these software provided the means to support the learning process which occurred on and off-campus in a first-year undergraduate science subject.

WebCT provided a hidden pathway and search tool, which were used to provide a scientific writing database, and communication tools, which provided a means of communicating scientific knowledge amongst students and the lecturers as they engaged in pre-writing and writing activities. The word-processor provided the means by which students could engage in the pre-writing exercises, and could produce a written product which could easily be edited for meaning at the structural level.

In order to design the technologies so that they provided domain-specific learning processes (Laurillard 1993), considerable effort was put into the production of computer-based learning materials which dealt with the science being studied. A small team comprising the science lecturers, some students, applied linguists and a learning lecturer collaborated to produce the materials which fell broadly into two categories: database exercises which treated the scientific topic under consideration, and database items available as feedback on written tasks submitted by the students. The lecturers felt that the computer-facilitated learning (CFL) materials and processes would stimulate student engagement with the science for a number or reasons: the materials were specifically related to the scientific topics that were investigated in their workshops and lectures, the materials were pitched at an appropriate level because of the input provided by both the lecturers and students in their design, and the CFL processes were embedded into the assessment framework.

## The Learning Context

At the University of Western Sydney, Hawkesbury (UWSH), collaboration between lecturers from the Faculty of Science and Technology, and the rest of the team from the Centre for Higher Education Development produced the interactive learning environment to help students develop their understanding of the science and their academic literacy skills. The students enrolled in *Plant Science and Physiology (PSP),* a core subject in the first year undergraduate science degree, typically display a wide range of literacy levels which do not always indicate an ability to cope successfully with the demands of a tertiary education. In order to address this situation, the lecturers designed the ILE to encourage students to construct their own understanding of the science by writing about it. In order for the Plant Science and Physiology ILE to support writing to learn processes, a writing portfolio was used as the basis of its design. *Portfolio* is used to refer to a series of writing tasks which the students are required to complete as the term progresses. Each writing task requires the students to engage with the contents of the lecture, readings and workshop for the week. There are between nine and twelve writing tasks that a student is expected to submit and the length of the writing tasks is usually between 300-800 words. The collaborating lecturers wanted an ILE that reflected an approach of writing to learn. They believed that such an approach was likely to help design learning processes which would satisfy the individual literacy needs of the students as well as help them to engage with the science. The lecturers had found that while some literacy problems were common to the group, there were others that were specific to individual students and so they wanted an ILE that would meet both the needs of the group and of the individual. To do this, the ILE would have to provide a sufficient number of resources so that students could make choices which would meet their individual needs. This could be achieved through a student-centred approach to the design of the ILE.

## A Student-centred Approach to the Design of ILEs

In order for the ILE to meet the learning needs of the group and the individual, a student-centred approach to its design was adopted. Lecturers

who value a student-centred approached to teaching and learning are concerned that the learning processes facilitate a number of important steps. The learning process should allow and encourage the students to take control over learning, they should provide choice in learning pathways and they should help the students to become independent learners (Ramsden, 1994).
To ensure that the Plant Science and Physiology ILE supported student-centre learning processes, a continuing dialogue guided its development. Participation in this dialogue not only involved the lecturers, applied linguists and technology providers, but also the students who were to be the eventual users of the ILE. Including students in the design of learning processes is an important aspect of student-centred learning (Laurillard, 1993). Past and present students' input into the dialogue was collected through formative and summative evaluation processes seeking their opinions about the sorts of learning processes which would best help them develop their understanding of the science through writing about it. In addition, with the agreement of the students, the model texts used in the database were taken from student-produced texts. Annotated by the applied linguists to highlight desirable features and then checked by the science lecturers to ensure scientific accuracy, the texts and text fragments demonstrated a visible learning outcome to the students. The texts in the database helped the students to gauge the distance between what they were producing and what was expected by the lecturers.

The learning processes of the ILE support the development of the students' *discipline-specific written literacy*. This term is used to refer to those written structures that accurately reflect the students' understanding and knowledge of the field of Plant Science and Physiology, produced to a standard which is acceptable from first year undergraduate students. In practice this means that the students require learning processes which:

- help them to develop successful planning strategies for their writing
- provide timely and appropriate feedback at all stages of the writing process
- provide appropriate and domain specific textual models of writing
- ensure instructive feedback on completed writing tasks
- help them construct their own understanding of the science

An important influence on the design of the ILE, and a motivation behind the development of its comprehensive database, was the teaching methodology chosen: genre-based literacy pedagogy (Martin, 1999).

## Genre-based Literacy Pedagogy

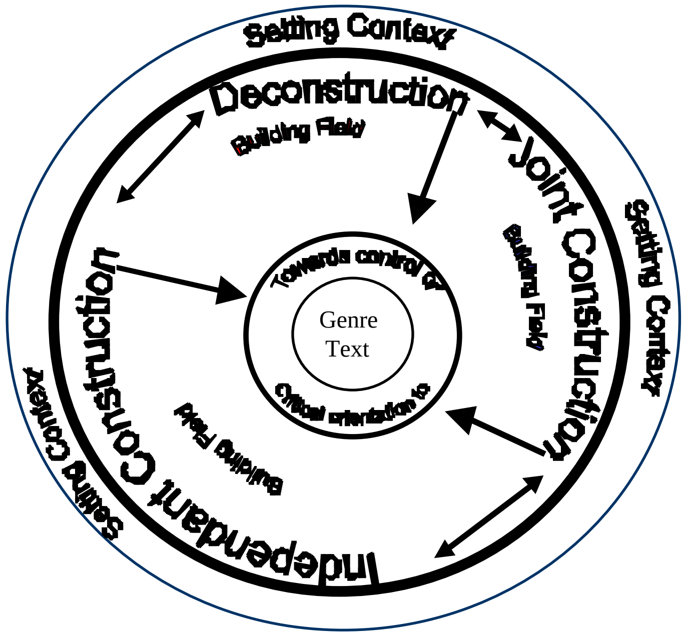


*Figure 1 – A Genre-based Teaching and Learning Cycle (Martin, 1999:131)*

The teaching and learning process represented by the above model is divided into three stages: deconstruction, joint construction and independent construction. Learning within the process can begin at any point dependent on the students' needs. At all stages of this cycle, the social context of the genre and field knowledge required for the writing task are considered and made explicit (Martin, 1999:130). The deconstruction stage of the cycle is a critical analysis of models of the genre under focus. These models can be analysed for content, structure and language features to provide insight about the genre and register to the students. The joint construction stage foregrounds collaboration between the participants of the learning process in preparation of the text, and the individual construction stage focuses on the production of a text by each student.

The interactive learning environment was designed to support this teaching and learning cycle. The scientific writing database provided 50 exercises which modelled the genre and register of the science being studied. The bulletin board augmented the choices available to students when they engaged in joint construction and the database contained an additional 300 items which provided feedback to the students on the writing tasks. By using these resources in preparation for their writing portfolio tasks, the students were required to actively engage with the science. Output from the exercises, the bulletin board and use of the database items indicated whether or not students were doing sufficient preparation before handing in their writing portfolio tasks.

## The Plant Science & Physiology Interactive Learning Environment (PSPILE)

The design of the Plant Science and Physiology ILE is depicted in Figure 2.

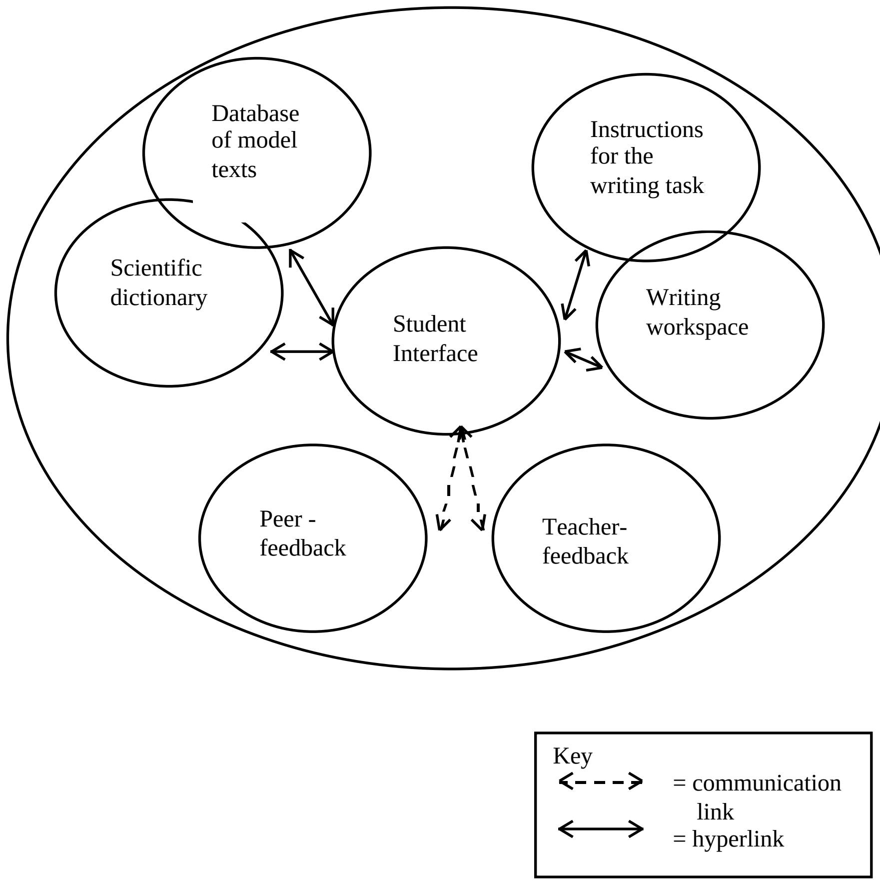

*Figure 2 - The Design of the PSPILE*

Simply represented, the PSPILE is an integration of computer-facilitated learning (CFL) tools which support the writing process. At the centre of the model is the student, accessing the PSPILE through a single interface. While WebCT and Microsoft Word provided the CFL tools used in this environment, the same result could be achieved by using a combination of similar CFL tools. From the single interface, the student uses the writing portfolio instructions and workspace and the writing resources, the database of model texts and the scientific dictionary. The interactive nature of the environment is provided by the communication tools, indicated by the broken arrows in Figure 2, which facilitate feedback processes between the student and his/her peers and between the student and the teacher.

The CFL tools used in the environment include communication tools such as topic-driven flora in the bulletin board and email (provided by WebCT), search tools, pathway tools, a glossary, and word-processor files (Microsoft Word). Each tool plays a role in supporting the processes used to develop the students' ability of writing to learn. The communication tools provide channels for feedback to occur, the pathway tools provide a means for instructing the students and a searchable database in which text models are available, a glossary provides a scientific dictionary and the word-processor files provide a work-space in which the students complete pre-writing exercises, outlines, drafts and final texts. These tools, which are generic to most monolithic learning environments, have been contextualised by a rich framework of learning materials.

### *The learning materials of the PSPILE.*

The learning materials of the PSPILE are determined by the scientific syllabus. The topics covered are:

- cell biology
- plant nutrition
- the domestication of plants
- the structure of genomes
- DNA
- Plant Growth and Development

Students are required to submit one or more writing tasks on each of the topics. The genres of the texts vary and tend to be elemental rather than macro genres (Drury, 2000). Early in the term, students are required to write texts which summarise lectures and their readings and reports about experiments in tutorials. Other texts include explanations, descriptions and discussions of various topics. Each genre has a distinctive purpose and a distinct structure to meet that purpose (Martin, 1985). Lecturers tried to ensure a general trend in their sequence by designing the simpler tasks such as summaries and description towards the beginning of the semester, leaving the more demanding genres until later.

In preparation for the production of the learning resources of the PSPILE, the lecturers used the writing portfolio as part of the assessment system in the delivery of the subject in 1999. By doing so they were able to collect texts for the database from those students who agreed to contribute. Students contributed writing portfolio tasks on a range of PSP topics that covered the length and breadth of the curriculum. A small number of the sixty five students in the subject chose not to contribute any texts.

A selection of around three hundred texts and text fragments were chosen for the database. The texts were annotated for desirable scientific and linguistic features and each item of the database was vetted for scientific accuracy. These resources were used for textual modelling and for the purposes of feedback. Textual modelling, within the learning process of genre-based literacy pedagogy, uses models of the target texts as a guide for the students when they produce their own. Textual modelling provides students with domain specific literacy learning processes. The use of model texts which are appropriate to the domain (Laurillard 1993) or field (Halliday, 1978; Halliday and Martin, 1996), that are pitched at the right level, that are appropriately structured and represent the sorts of texts that the students should be producing themselves, is a fertile method of instruction for students wishing to construct their own understanding and written expression of the science. The knowledge domain shaped the design of the database. The elemental genres used in the science were modelled for content, structure and language features (Drury and Webb, 1989). Consider the figures below. They model a paragraph from a writing task which investigates the properties of water. In the database, the paragraph sections are identified through the use of colour. In the examples below, the sections are identified through use of font styles.

| **Model Paragraph** | **Explanation** |
|---|---|

| | |
|---|---|
| **One property of water is strength.** Characteristics of its strength include incompressibility and surface tension. *The surface tension of water enables some insects or bugs to run on the top of ponds. Surface tension is the result of the cohesion caused by the strong attraction between water molecules as a result of the hydrogen bonding. It is most evident at interfaces between water and air. This occurs because the attraction between the water molecules is much stronger than between the air and water. The surface water is constantly being pulled down to join the bulk water and away from the air which creates a membrane-like effect. A water bug does not sink in water because it does not exert enough force to overcome the surface tension of the water.* The incompressibility of water is another characteristic of its strength. Water is essentially incompressible when it is in a liquid state. When water freezes, it becomes larger in mass. If, for example, it is lodged in the crack of a rock, it will eventually break it after sufficient cycles of freezing and thawing. Repetition of this process will cause weak points to develop in the structure of the rock causing it to break. | ***Content & structure*** *What sections should the paragraph contain and what are their purpose?*<br><br>**Identify the main idea of the paragraph.** Identify the characteristics of water that demonstrate its strength *Explain the concept of surface tension. Include an explanation about why a water bug will not sink when it scurries over a pond.* Explain the concept of the incompressibility of water. Give an example of how can water break a rock.<br><br>NB Note the sequence of science identified in the paragraph |

*Figure 3 – Database item 03ex.01*

Figures 3 and 4 provide examples of some of the materials in the database. By scaffolding the science and language of the texts in this manner, students have access to the genre and register of the texts which have been identified as successful by the lecturers and previously enrolled students in Plant Science and Physiology. By providing such materials in the database, students have control over the choice of items that they use in their writing preparation and feedback processes. Other scientific materials used by the students were available in the glossary.

| **Model 3a** | ***Commentary*** |
| --- | --- |
| **One property of water** is strength. **Characteristics of its strength** include incompressibility and surface tension. **The surface tension of water** enables some insects or bugs to run on the top of ponds. **Surface tension** is the result of the cohesion caused by the strong attraction between water molecules as a result of the hydrogen bonding. **It** is most evident at interfaces between water and air. This occurs because the attraction between the water molecules is much stronger than between the air and water. **The surface water** is constantly being pulled down to join the bulk water and away from the air which creates a membrane-like effect. **A water bug** does not sink in water because it does not exert enough force to overcome the surface tension of the water. **The incompressibility of water** is another characteristic of its strength. **Water** is essentially incompressible when it is in a liquid state. **When water** freezes, it becomes larger in mass. **If, for example, it** is lodged in the crack of a rock, it will eventually break it after sufficient cycles of freezing and thawing. Repetition of this process will cause weak points to develop in the structure of the rock causing it to break. | *The information at the beginning of the sentences establishes the focus for the paragraph.* ***The phrases in bold*** *focus the reader on a property of water, strength, its characteristics and some examples.* |

*Figure 4 – Database item 03ex.03*

The glossary in the PSPILE adds depth to the support of the students' writing as they engage with the scientific lexicon. One of the challenges for students writing in a scientific field is mastery of the technical terms. A technical lexicon represents the world in a different way to an everyday lexicon (Martin, 1996). Students too often use a term without defining its meaning or explaining its relevance or with inappropriate relationships to other terms. Including a scientific dictionary in the learning environment provides students with the means to develop additional strategies to become familiar with the new terminology that they must master.

The communication tools used in the environment provide the means by which a number of feedback processes may occur and ensures the interactive nature of the PSPILE. Students can use the bulletin boards to ask their peers and teacher for advice, and they can use the chat room to discuss the whereabouts of writing resources, share planning strategies, and outlines of texts. Teachers can use the communication tools to encourage peer feedback and to provide individualised feedback, which is important in a student-centred approach to improving the students' literacy levels (Duin and Hansen, 1994). The communication tools in the PSPILE contribute to the interactive nature of the environment and facilitate three types of feedback, as described below.

## The interactive Nature of the PSPILE

The interactive nature of the PSPILE takes the form of various types of feedback which help the students to improve their writing. The feedback in PSPILE includes individual feedback provided by the lecturers, peer feedback which is teacher-led and direct peer feedback.

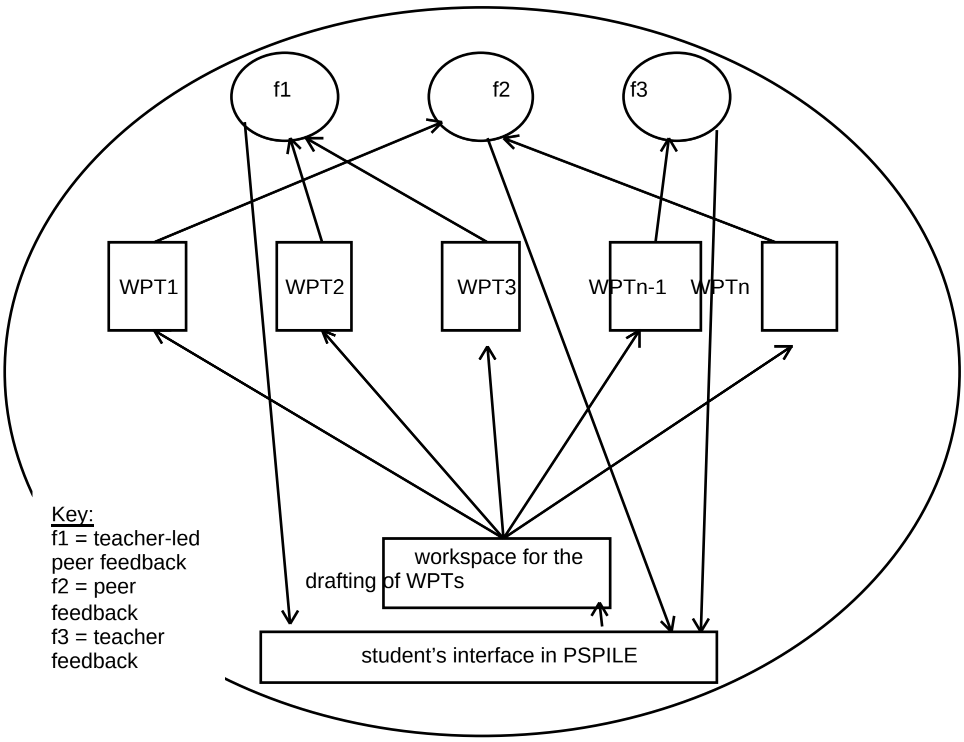


*Figure 5 – The Interactive Nature of the PSPILE*

Figure 5 depicts the interactive nature of the PSPILE. In Figure 5, the *workspace for the drafting of WPTs* are the embedded Microsoft word files that guide the students through the steps of writing the portfolio tasks. Each student can access this from his/her interface in the PSPILE. The symbols labelled *WPT1….WPTn-1,WPTn* represent all the writing portfolio tasks that a student may submit as part of the writing portfolio.

The ovals labelled *f1, f2, f3* represent the types of feedback that students will receive. *f1* represents teacher-led peer feedback. This can take many forms. One example of this type of feedback is the posting by lecturers of a number of successful writing tasks written by the enrolled students. Given the students' agreement, lecturers are able to annotate the texts in order to highlight the desirable linguistic and scientific features that make the texts successful. Students, recognising that their peers have created these texts, are then able to use them to guide their own text creation. Another type of teacher-led peer feedback included in *f1* may be the selection of a few writing tasks which have been written by the students. Then, posting these within the PSPILE, either using a bulletin board or an individual web-page, so that the authors remain anonymous, students can be asked to vote for the best text and explain why they think it is the most successful. Their feedback can be posted using the bulletin board, an email discussion list or a chat room.

*f2* represents direct student feedback on writing tasks. This can come before, during or after the text production process via requests for help using the communication tools of PSPILE from one student to another. Students are encouraged to seek peer interaction during the joint construction stage. Often they are required to demonstrate this interaction as part of their assessment. *f3* in Figure 5 represents individualised feedback on writing tasks given by the lecturers directly to the student. Lecturers are able to individually tailor the feedback given to students by annotating their texts using the functionality of Microsoft Word. The lecturers can colour code desirable and problematic structural features of the text as a method of providing feedback. They can also refer students to relevant model texts that are in the database. Providing multiple sources of feedback in the learning process allows students to choose which they will use. This potential increases the student-centredness of the outcomes provided by the PSPILE as students create their own learning pathways.

## The Student-centred Outcomes *o*f the PSPILE

The student-centred outcomes of the PSPILE encourage the students to engage with the science by permitting them to choose their own learning pathways. This is realised in the creation of learning processes which are potentially unique for each student. When engaging in a writing task, students can create individual learning pathways that suit their own needs.

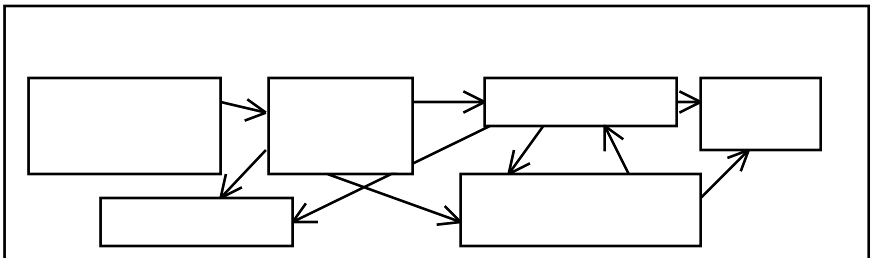

*Figure 6 – Examples of individual learning pathways possible in the PSPILE*

Figure 6 exemplifies the potential of the PSPILE to provide individual learning pathways. When student 1 begins with writing task 3, s/he engages in task planning and text production. To do this, student 1 has accessed the database and chosen one text (1.2) to help with the process. The student has also made use of teacher-led peer feedback (*f1* ) and made heavy use of peer feedback ( *f2* ). These are the elements of the learning pathway chosen by the student before submission of the text.

Student 2 has gone through a different learning pathway. The student has used three textual models (2.3, 1.4, 1.5) and used a different mixture of feedback processes (*f1, f1, f2,f3*) relying more heavily on teacher-led peer feedback. Again the student has controlled the learning process by choosing a pathway that provides self-determined help before task submission. By combining the PSPILE learning materials and processes in different ways, the students create their own learning pathways.

## Conclusions

Writing to learn is a strategy for student engagement in learning which has not yet been fully exploited at the tertiary level. By drawing on the potential benefits for learning from this strategy, it is possible to design an interactive learning environment which can provide domain-specific, student-centred learning processes. These processes provide valuable support to students as they construct their own understanding of the knowledge domain as they write.

Embedding a pedagogical approach to teaching and learning in the design of the ILE is an important step in the successful design of such environments. In the PSPILE, the genre-based literacy pedagogy is embedded in the design of the database, which provides the resources for modelling and feedback, the use of the communication tools, which augment choices in the mediums available for joint and individual construction, and the design of the word-processor files, which provide the means by which students can interact with the science in order to demonstrate their engagement with it.

Cleary an important ingredient in the successful production of ILEs such as the PSPILE is collaboration between a number of key groups: lecturers, students, learning-specialists and technology-providers. If lecturers wish to produce student-centred ILEs, involving the students is essential. Successful collaboration between staff and students is one of the continuing challenges faced by all those who are concerned with student-centred learning. Further research into the PSPILE and similar environments could investigate the strategies and motivations adopted by students when technology is involved in the learning process. Focusing on the impact of ILEs on learning from the students' point of view in this way is likely to provide important knowledge that would assist in the design, delivery and evaluation of technically-supported learning processes.

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