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# Contents

# Integrating Communications Skills with Discipline Content

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**Abstract**

The development of communication skills in Computer Science majors has become a priority, with industry identifying the development of communication and critical thinking skills as an area in need of reform in the higher education sector. There are benefits in the teaching of communications skills as a dedicated course, such as extensive face-to-face time and feedback on communications activities. However, there are also benefits in the teaching of communication skills as embedded activities within a discipline course: activities become more relevant to students when they are directly tied to discipline tasks that all students are undertaking.

This paper reports on an intensive communications and critical thinking course that provides both depth in the study of communications skills and relevance through integration with discipline content. The main contribution of this paper is a description of a set of course activities within the ICT discipline; these activities represent examples of both informal activities designed to engage students regularly with developing their communication skills, and formal activities designed to assist assessment, including self- and peer-assessment. Our initial analysis of the progress of these students demonstrates increased clarity in the students' understanding of study and communication requirements, and improved performance in language-rich assessments.

## Introduction

It has long been recognised that information and communication technology (ICT) students must develop communication and critical thinking skills (ACM 2001, ACM, 2005, Kay 1998). However, the development of these skills is still an area needing reform and improvement; the 2009 Australian Learning and Teaching Council (ALTC) report, *Managing educational change in the ICT discipline at the tertiary education level*, identifies the teaching of personal skills, including communication of all kinds, as a key area for curriculum reform in the tertiary sector (Koppi and Naghdy 2009). ICT employers identified the areas most in need for improvement in curriculum reform as communication and problem-solving skills.

The teaching of communication skills is often undertaken outside of the discipline context, through generalised communication or study skills courses. This can provide benefit, as students are able to devote significant class time to the discussion and development of these skills. However, research indicates that communications skills can be best learned within the context of the discipline content, enabling students to see more relevance in their communications assessment tasks (Drury & Taylor 1999, Pollock 2001). Several studies have reported on Communication Skills courses designed for the Computer Science context, both as independent courses (Kay 1998) and through integrating communication skills content within an existing course (Anewalt 2002, Michael 2000, Pollock 2001). Perhaps the most

successful approaches to teaching communication skills are those based on Writing Across the Curriculum (WAC) (Fulwiler & Young 1982) where writing tasks are integrated into each course within the student's program of study. However, it is not always possible for students to take advantage of this gradual exposure to, and development of, communications skills. For example, articulation students often join mid-way through an existing program, and must quickly develop their communication and discipline skills.

This paper reports on an intensive communications and critical thinking course that provides both depth in the study of communications skills and relevance through integration with discipline content. This course uses a WAC approach to facilitate active learning of both technical and non-technical concepts, and extends this approach to facilitate familiarisation with assessment criteria and expectations. The main contribution of this paper is a description of a set of course activities within the ICT discipline. The course structure is based on the following principles:

- the integration of communications activities with discipline activities to increase student engagement,
- the use of both formal and informal activities to encourage reflection and engagement, and
- the selection of activities that reflect the different types of writing undertaken by a Computer Science professional.

## Related Work

Communication, including writing, has been identified as a crucial skill for Computer Scientists from both a professional perspective (ACM 2005, Koppi & Naghdy 2009) and also in terms of developing critical thinking skills (Anewalt 2002, Taffe 1989). The process of writing helps clarify thought, and can help students develop their understanding of new concepts.

Kay (1998) introduces a dedicated communication skills course for Computer Scientists that contains a wide range of communications activities including technical writing, oral presentations and writing for electronic media. Kay identifies several teaching strategies and example assignments that assist in structuring such a course. Several other authors describe discipline courses where writing intensive assignments have been integrated with discipline content. Michael (2000) moves directly from Kay's work to identify the strategies required in constructing an integrated communication skills course for Computer Scientists. Fell et al. (1996) identify a set of writing assignments that may be used from introductory to advanced courses. Several authors have defined course structures for specific discipline courses, including data structures (Hartman 1989) and junior programming (Michael 2000). Pollock (2001) discusses the structure of a graduate level course with an emphasis on writing for developing research skills, while Derrick (2006) presents strategies for efficient assessment within a similar context.

Dugan and Polanksi (2006) present a taxonomy of writing tasks, defined by writing for learning, writing for academic communication, and writing for industrial communication, and a general guide to incorporating writing into any computer science course. This taxonomy can be used to select a general subset of writing tasks appropriate for the purpose and experience of the students. However, more detail is required of specific examples prior to its application within an ICT course. Hoffman et al. (2006) present, within the context of WAC, a guide to moving from writing for learning to writing to communicate, either for academic or industrial purposes.

Writing across the curriculum (WAC) (Fulwiler & Young 1982, Young 1999) describes an approach whereby writing is integrated across all courses within the curriculum, and used as an active learning approach to facilitate the development of both non-technical skills and, through increased reflection, self-assessment and analysis, also technical skills. The WAC model is based on the following principles (Fulwiler & Young 1982):

- that writing is the responsibility of the entire academic community,
- that writing must be integrated across departmental boundaries,
- that writing instruction must be continuous during all four years of undergraduate education,
- that writing promotes learning, and
- that only by practicing the conventions of an academic discipline will students begin to communicate effectively within that discipline.

WAC programs typically promote the use of Writing to Learn (WTL) activities, which are informal writing assignments that enable students to analyse and develop key concepts presented in a course. This is in contrast to Writing in the Discipline (WID) activities, designed to model the formal communication required for professionals within a discipline. WID activities are common writing activities employed within discipline courses. Importantly, both kinds of assignments are not *add-on* assignments designed primarily to target communication skills but are necessary assignments in the development of discipline or technical skills. Hoffman et al. (2006) identify the need to provide a bridge between informal and formal writing activities, in that this 'removes obstacles to better writing and active learning in Computer Science'. McLeod and Maimon (2000) support the view that WTL and WID activities are complementary (and are both supported by the WAC principles), and express the importance of having both kinds of activities within a curriculum. Hoffman et al. (2006) provide a comprehensive overview of WAC, WTL and WID within Computer Science Education.

Taffe (1989) identifies three categories of writing within Computer Science: writing to develop facility with the language of the discipline, writing to explain results of a study, and writing as a process of clarification. It is the second of these that is commonly interpreted as a WID activity, while in actuality all three of these activities are undertaken by Computer Science professionals.

We have designed a communications and critical thinking course that uses a combination of WTL and WID activities to promote the development of both technical and non-technical skills for the three categories identified by Taffe. As we extend the principles of WTL and WID beyond the art of writing to other forms of communication, we refer to these categories as Communication to Learn (CTL) and Communication in the Discipline (CID).

## Course Context

In this paper, we describe an intensive communication skills course that is taken by articulating students—students who enter part way through the standard undergraduate programme. This cohort must quickly transition to study within a new tertiary institution, including adjustments to assessment expectations and discipline-specific communication skills. Our articulation cohort consists of approximately 60% international students from a range of Asian and South-East Asian countries, and 40% domestic students; together this cohort embodies a diverse set of skills and previous experiences and makes up approximately 25% of commencing enrolments in our undergraduate Computer Science programme.

Students from this cohort have typically reported difficulties adjusting to their new study environment, and dissatisfaction with their performance in their first semester. Students reported difficulty in understanding classroom expectations and assessment criteria, and a general feeling of being overwhelmed by their transition. The Communications and Critical Thinking (CCT) course forms part of a new articulation pathway, where students enrol in CCT in parallel to their discipline courses, consisting of an introductory programming course followed by a data structures and algorithms courses, and a free elective (see Figure 1). Class time in CCT consists of a 2 hour lecture and a 1 hour tutorial per week. Lectures involve the whole class (approximately 40-60 students) and contain a combination of brief didactic style lecture sessions, class discussions and time to work on, and review, brief CTL assignments. Tutorials are conducted in small groups (6-10 students), and consist of further CTL assignments, presentations and led discussions.

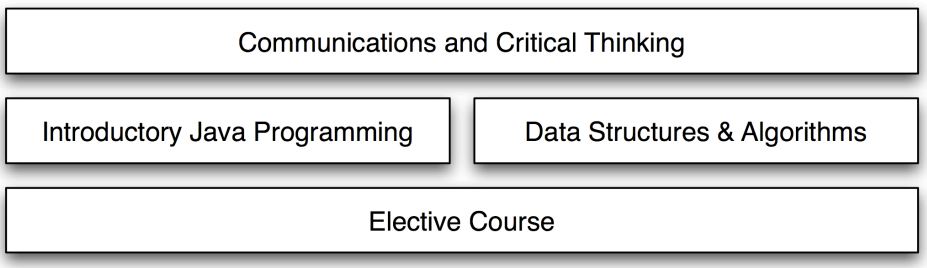


*Figure 1: First semester of the articulation pathway.*

## Course Activities

A combination of Communication to Learn and Communication in the Discipline activities are utilised through the CCT course. Figure 2 illustrates the order of assignments in the CCT course, with the writing of reflections and the development of an online glossary continuing for the course duration. In addition, students complete a series of presentations, brief WTL homeworks, online documentation (Application Programming Interface) and reports. Figure 2 also illustrates the relationship between the communication assignments in the CCT course and their counterparts in the discipline courses. Not all assignments in the CCT course map directly to discipline assignments. Our intention is to construct a course with a combination of informal assignments that are loosely mapped to discipline content, in order to enable students to flexibly explore concepts, and more formal assignments that directly support more difficult assignments (and concepts) in the discipline courses. In addition, as this is the first semester of study for these students, we also include two assignments that are designed to excite students and to enable the students to explore the broader ICT field.

The CTL activities consist of informal graded assignments for which the students receive written feedback, and informal homework assignments that students are required to complete prior to class. Homework assignments are not graded, but peer and instructor feedback is provided during class. The CTL activities are used to model learning activities that students could adopt throughout their program of study in order to facilitate understanding.

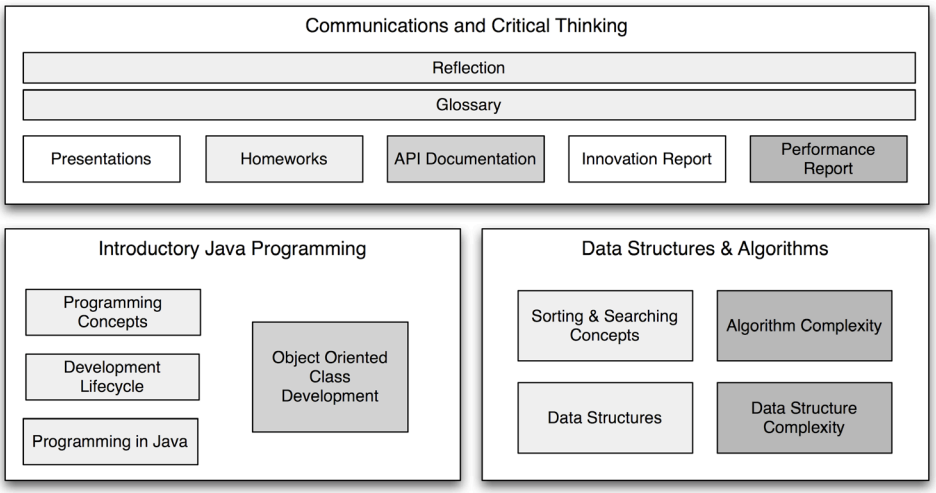


*Figure 2: Relationship of Course Activities to Discipline Content.*

***Personal Reflections***

Each student is provided with an online blog and required to provide an entry each week for the duration of the course. The students are requested to write freely about their study experiences, their adjustment to their new environment and their thoughts on their learning both in the CCT course and their discipline courses.

Students typically used this activity to summarise the key concepts from their discipline courses. Some students used this activity to communicate with their lecturers, by including specific questions and comments directed to their lecturers. It is known that Asian students will often not discuss their personal feelings in a face-to-face class setting, so it is important to provide an alternative means of communication for self-disclosure and sharing of personal stories (Liu 2001, Wang 2006).

***Homework***

Informal formative homework activities that required students to complete a small writing task prior to, or during, class. At specific points during lectures, students were asked to provide feedback on another student's homework prior to a whole-of-class discussion on the writing task. A variety of writing tasks were chosen, influenced by Zobel (2004):

- Select a section of your textbook (less than 1 page) and identify the five main points.
- Take the five main points you constructed earlier and rewrite the section without looking at it.
- Select a section from your textbook (1-2 pages) and summarise it in 500 words. Repeat this using 400 words, then 300 words and finally 100 words. Which is the best version?
- Write a pseudo code description of the following algorithm: ...

These exercises enabled students to focus on small text construction, while also teaching them to analyse and prioritise discipline information.

***Presentation***

Students were asked to prepare a small presentation on a topic of their choice. Analysis of international students and students undergoing transition indicates that to build engagement in any class, it is important to introduce activities that support social interaction and build mutual support, such as encouraging students to share their biographies or other personal stories in a safe atmosphere (Paloff and Pratt 1999). As such, this first presentation could be on a technical or a non-technical topic; approximately 40% of the class, typically students with some industry experience, elected to present on a technical topic. Students were provided with an assessment rubric for the presentations as a guide to assessment criteria, however this presentation was assessed only by their lecturer. Detailed feedback, using the rubric, was provided to each student.

***Glossary***

Students were asked to contribute to an online collaborative glossary, with each student required to contribute one new term, or make additions to an existing term each week. This activity enabled students to focus on understanding the new language of their discipline, as well as clarifying connections between concepts.

The CID activities consist of formal graded assignments that are more directly linked to their discipline content, and model writing activities that students would undertake in their remaining discipline courses and also as professional Computer Scientists. Detailed assessment criteria are provided for each activity, with an emphasis on understanding assessment criteria integrated into the assessment of both CTL and CID presentation activities.

***API Documentation***

Students were required to develop detailed online Application Programming Interface (API) documentation for a Java class they had developed in their introductory Java programming course. Students were required to use the Javadoc automated documentation environment to develop their API documentation. This assignment is perhaps one of the most formal assignments, in that students were asked to provide an algorithm description for each method in their class. The students were required to use specific discipline language constructs to describe the algorithms, identifying any special cases and providing an explanation of data used in the method. Students were also asked to provide several examples of the usage of each method, highlighting special cases. This activity enabled students to develop a better understanding of the algorithms they had developed and implemented, and also a better understanding of how to use documentation.

***Innovation Report***

Each student was asked to research and write an Innovation Report on an innovative technology of their choice. Demonstrating the creativity and breadth of the ICT are, this assignment asked students to identify a new innovation, provide evidence as to how it is innovative and a brief description of how this innovation might change our world. The Innovation Report enabled students to develop their research skills within their discipline and, although many students reported that they had completed essays before, that undertaking one in their own discipline was more interesting and also more difficult, as they had to master discipline concepts in order to understand their innovation. This activity addressed the need for students to develop research

and citation skills, as well as the ability to critically analyse information and select appropriate reference sources.

***Innovation Report Presentation***

Students were asked to present a brief (10 minute) presentation of the innovative technology identified in their Innovation Report. Students were assessed using the same assessment criteria as their informal presentation, and were also asked to complete peer-assessment for one other student. Building on the feedback from their CTL presentation, this enabled the students to reflect upon their own assessment and to better understand assessment criteria.

***Performance Analysis Report***

The most technical of the activities, students were asked to write a performance analysis report of two data structures studied in their Data Structures and Algorithms course with the aim of clarifying understanding of algorithmic complexity—a topic that had previously been identified as one with which this cohort had had difficulty. Students were required to complete several distinct stages in this activity, starting with the identification of their hypothesis—verification of algorithmic complexity, the design of a series of experiments to test their hypothesis, the design and completion of a test code suite to undertake their experiments, and the final write up of all of the stages along with the analysis of their results. This activity was designed to develop understanding of the process of performance analysis, as well as models for documenting performance information.

Table 1 provides a summary of the activities used within the CCT course, and their mapping to the categories of computer science writing as identified by Taffe (1989): writing to develop facility, to explain results of a study, and to clarify concepts.

*Table 1: Communication to Learn and Communication in the Discipline activities*

| Activity | Writing to develop facility | Writing to explain results of a study | Writing to clarify concepts |
|---|---|---|---|
| Personal Reflections | X | | X |
| Homeworks | | | X |
| Presentation | X | | X |
| Glossary | X | | X |
| API Documentation | | X | X |
| Innovation Report | X | X | X |
| Innovation Report Presentation | X | X | X |
| Performance Analysis Report | X | X | |

## Assessment

The approach taken in the assessment of all activities is that of modeling appropriate writing rather that a detailed assessment of writing or communication errors. Students were provided with exemplars for each activity and were encouraged to reflect upon and discuss their own work with their peers and academic staff. Students participated in frequent peer reviews via homeworks discussed within lecture sessions, tutorial discussions and explicit peer reviews of presentations. Students were provided with one opportunity to discuss

drafts of formal written assessments (i.e. the innovation and performance reports) prior to their submission and were encouraged to self-review in order for them to make the best use of this discussion opportunity.

## Evaluation

Students found the activities in the CCT course to be more challenging than those they had previously undertaken in general Communications Skills courses. This is unsurprising, in that our expectations were greater: students are developing discipline knowledge and facility with communication concurrently. However, students also found these activities more rewarding and helpful in developing their understanding of discipline content.

The Course Coordinators for the related courses (Introductory Java Programming and Data Structures & Algorithms) have reported increased performance by these students in both understanding assessment tasks and in completing language-rich assessments. Preliminary analysis of their examination results in the Introductory Java Programming course demonstrates improved performance in language-rich assessments. Final examination questions for this course were classified as either mathematical or linguistic, based on whether the question could be solved using a mathematical solving method, or required deeper understanding and discussion of concepts. It was found in our preliminary analysis of this course, that students who had undertaken the CCT course achieved better performance in the linguistic questions than previous cohorts. We believe that the skills developed within their course enabled students to extract more information from their question and then provide answers in a way that matched the assessment criteria, supported by a reduction in examples of repetition from the course notes. We will be tracking the progress and performance of these students throughout their studies, with results available at the end of 2012.

Perhaps the best way to analyse the impact of the CCT course is to ascertain whether the students involved in the course felt the impact of the course activities on their communication skills and their understanding of discipline content. It is worth noting here that many of these students are unfamiliar with both informal and formal communication in English. Within the 'reflection' exercise, students were asked to write freely about their experiences with the course, and reflect upon both the changes to their learning and their understanding of appropriate study skills throughout the semester:

> *'At the first three days of this week, I was doing my report. Via the writing of report, I realised that understanding data structures was really important.'*
>
> *'This week I started to prepare my performance analysis report. It was my first time to do write this kind of report. It is much harder. I needed to test more and analysis the programs much deeper. It was a good way for me to understand the programs what I need to analysis.'*
>
> *'It is the last week of Communication and Study Skills lessons. When I looked back the whole fifteen weeks study. I found that I improved fast. I have learnt lots of new computer terms and how to write an analysis report. And through the personal reflections, I got the way I need to improve. It let me know the situation of my study much more clearly. Of course, from this subject, I learnt more about [how] I am learning.'*

The activities included in the CCT course provided students with multiple opportunities to reflect upon their learning and the differences between the study environments of their

institutions. This provided valuable feedback to the lecturers of the course, which in turn was used to guide the instruction in their discipline courses. For example:

> *'After two weeks of study in the Uni, I've found the teaching styles are much more different from the old ones I had before. Lectures are the most common teaching method here. Teachers give the most important points of the course during the lectures and we still need lots of time after class to understand and master the contents from lectures. We are expected to participate during the lecture. Such as asking questions and answering teacher's questions.…'*

The opportunities to reflect also provided students with a space for self assessment, enabling them to review their understanding and their previous work. For example, the following two comments from the same student demonstrate both initial frustration at the challenge of their new environment and their pleasure at their subsequent success.

> *'All the week, every classmate are working on the practical exercises. It is really a hard work for a newcomer student. Frequently, I think I have mastered the knowledge after took the lecture, however, once I'm in practice in front of the computer, I found it's not quite as I thought before. Even more, I can not run a program. I believe that is the main difference between practice and merely thinking.'*

> *'With increasing practice, I become more familiar with Java. I think there is a lot of interesting things while I'm designing a program. I like this feeling. It makes me very exciting [sic] while I work out an exercise.'*

## Conclusions

Communication skills has been identified as a crucial skill area for Computer Scientists, both in the professional day to day activities and in the development of critical thinking and analysis skills. This paper presents the structure of an intensive Communications and Critical Thinking course designed to use the development of communications skills as active learning activities to develop discipline-specific skills. A set of communications activities is presented that can be connected easily with discipline courses. The range of activities presented provides a rich exposure to the benefits of writing: increased facility with using discipline language, increased understanding of technical concepts, and increased understanding of the student's own learning.

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