Using a self reflective journal to enhance science communication

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Abstract

In new times the ability to self-evaluate and reflect on one's own

actions in communicating with others will be a crucial workplace skill. An innovative peer tutoring course for academic credit, by university science students in high schools, will be presented, with a review on its ability to develop a link between school tutoring and workplace communication. Course content relates to broad issues of science literacy, science communication and group situations and peer interactions. Students complete on-campus lecture and workshop component, and do 20-30 hours of in-school tutoring; assessment includes an examination, assignments in the form of journals, and a personal learning log of experiences.

Findings from the first two years of the course, based on data sources of students' journal entries and responses to the end of unit evaluations (1996, n = 21; 1997, n = 21) are presented. Analysis focuses on the development of reflective skills and students' awareness of their personal power in detecting and solving problems and developing strategies to promote two way communication. The use of self-evaluation through reflective journals was found to enhance the effectiveness of tutoring. Implications for developing the 'human side' of science will be discussed, and the appropriateness of the course to develop these often under-represented aspects of science.

Introduction

University courses are often criticised for not developing the communication skills necessary for the workplace (Candy & Crebert, 1990; Resnick, 1987). Resnick argues that education should " focus its efforts on preparing people to be good adaptive learners, so that they can perform effectively when situations are unpredictable and task demands change" (1987, p. 18). Echoing Dewey's notions of democratic education, Resnick envisions a civic function for education that involves a "culture of reason, analysis, and reflection, based on certain shared knowledge" (p. 19). This requires a model of education

based on shared intellectual functioning and community.

The STAR programme

In 1994 Murdoch University in Perth, Western Australia began a peer tutoring programme, Science and Technology Awareness Raising (STAR), which placed university science and mathematics undergraduates in local secondary schools. STAR's main aims were to raise the aspirations for science and technology of secondary school students (tutees) and in the process, develop the communication skills of the university students (peer tutors). Experience from the initial years of STAR indicated that many university science students were not confident meeting and establishing working relationships with others or communicating their knowledge of science, to the extent this would not facilitate gaining initial employment, and developing effective practices in the workplace. From discussions with the STAR personnel it was apparent that many tutors needed support to develop their communication skills.

To meet this need the School of Education introduced a unit of study, Peer Tutoring and Mentoring in Science in 1996. It was composed of an on-campus component (two hour-long seminar/workshops per week over ten weeks of semester) conducted by three School of Education lecturers, and an off-campus or in-school component (peer tutoring half a day per week in a secondary or primary school) organised through STAR (see MacCallum & Hickey, 1997 for a more detailed description of the unit and its rationale, and Elsegood, MacCallum, Hickey & Jeffreys, 1997 for an overview of developments of the STAR programme). The unit was designed to focus on aspects of interpersonal communication and science communication skills, by developing students' skills in analysis of successful and unsuccessful communication incidents, and reflection on causes and possible solutions to these situations. The self reflective journal was an ideal strategy to meet this need, as it allowed for the wide diversity of situations students worked in.

This paper discusses the use of reflection in the first two years of the unit. In the first year (1996), 21 science students enrolled, and 28 in the second year. Three dimensions of use of reflective journals are discussed - the personal, science, and social. Extracts of students' reflective journals, assignments and end of unit evaluation surveys, together with participating teacher feedback are used to illustrate the ways students used reflection and its effectiveness.

The self reflective process

Over the last decade the concepts of reflective practice (eg Schon, 1983, 1987) have become popular in educational writing (Boud, Keogh & Walker, 1985; Liston & Zeichner, 1991) and been implemented in growing numbers of teacher education programmes (e.g. Dart & Clarke, 1991; Dart, Boulton-Lewis, Brownlee & McCrindle, 1996; Hatton & Smith, 1995; MacCallum, 1996) and science programmes (McCrindle & Christensen, 1995). Building on Schon's concept of 'knowing-in-action', Boud et al. (1985) have devised a three-component model that incorporates experience(s), reflective processes and outcomes.

This concept of reflection dovetailed with the rationale of the unit which was to support peer tutors in their endeavours in schools, to improve the effectiveness of their tutoring, and to develop their personal and professional communication skills. This was to be achieved through developing peer tutors' substantive knowledge and understanding of issues relevant to peer tutoring, providing a context for exchange of information and experiences, and engaging tutors in reflection on their experiences to assist in their self-adaptation to their individual tutoring contexts. The integration of substantive knowledge and peer tutoring experience was to be a key element in the implementation of the unit. These experiences and skills were also to be linked to more general areas of science communication beyond peer tutoring.

Specifically, for this unit, the Self Reflective process was developed

through four key aspects: students' journals, seminar themes, workshops and assignments based on the journals.1 Each aspect allowed reflection to be further developed and refined. The students' journal entries of their experiences in classes and the seminar themes provided the mix of practice and conceptual knowledge. The workshops allowed students to discuss the concepts developed in the seminars, to share tutoring experiences and to tentatively build bridges between the two. The assignments based of the journal provided a structure for students to further make connections between conceptual knowledge and experience and to work through ways to improve their tutoring practice in their specific contexts.

1. Journals

Tutors were required to keep a 'journal' of their peer tutoring experiences. Guidelines given for this journal suggested that each session at the school was described, initially in general terms about the students, classes, teacher and the way the classes differed. These general observations would be supplemented by a closer focus on one student or a small group of students, and on specific episodes which were to be examined from perspectives introduced in seminars, relating to the themes of the unit.

Tutors' reactions to the idea of a reflective journal were mixed. For some, it proved very difficult to move away from the traditional, formalised and depersonalised science writing style, where the effort was to virtually remove the individuality and subjectivity of the writer, to this journal which required such an approach. Students' early attempts were little more than descriptions of what happened in the classrooms they visited or critiques of the school system, science teaching or student behaviour:

Miss X always organised her class into groups before they begin the lesson. Most of the time, the kids get themselves together among their friends. Sometimes Miss X would randomly pick the students from the

attendance sheet, generally mixing the girls and boys together. Some responses were very immature. A few boys would start to make silly remarks about girls...

Others observed and tried to make sense of the interactions between teacher and student, and made use of this understanding in subsequent interactions:

Bud again goes into explanation... I feel at this moment he simply needs to get this off his chest. I feel the teacher also feels this and as a result listens to him and asks questions that makes him answer more deeply about the problem, rather than advise him...

It has taken me a long time to become accustomed to the ways of Bud... I took my cue from his body language, and rather than make him feel like a dunce, I acted as though I genuinely wanted to work through it with him. Although he did not realise it, his "OHHH I get it.." was the dead give away... as although he did not tell me he had a problem, he confirmed by...

2. Seminar Themes

Weekly seminars developed the unit around three themes: interaction for learning, science communication, and learning in science. Supporting the seminars was a Reader, a collection of articles with commentary which prompted self reflection by providing background for discussion on each theme (MacCallum, Hickey & Schibeci, 1996). The readings were chosen from the fields of science education, group work studies, peer tutoring studies, cognition in science development and learning, public perceptions of science, constructivism, and the role of schools and education in society.

The theme of Interaction for Learning concentrated on peer tutoring issues, such as learning through interaction and the benefits to thinking and learning of sharing ideas, listening to others' views, and refining your own views; cooperative group development and group

skills; and changes in group dynamics over time, with people establishing routines, expectancies, and ways of operating. The second theme of Learning in Science looked at misconceptions in science, and how resistant these are to change; how questions could support others to learn; and how expectations of society of schools and educational institutions influence our views of the roles of teachers, students and tutors. The theme of Communicating Science examined community views of science; stereotypical views of scientists and the role of the media; and a study of public perceptions of gene technology, and how scientists work to change such views.

3. Workshops

Workshop sessions were an opportunity to elaborate and discuss the set readings for the week and to place this in the realistic and immediate context of tutoring experience. Tutors were encouraged to give examples of their experiences in classrooms, as evidence for their view point, in small group discussions about issues raised by the topic. Journals were used as the starting point for many of these sessions, with students reading aloud to their small group, to add verisimilitude to the discussions.

For example, one group discussion focused on involving students in communicating with the tutor. One tutor said that it was difficult to 'break the ice' sometimes with high school students who needed help, and reported:

He had not asked for help yet, but had spent a long time with the question doing nothing, just yawning, acting disinterested... with a 'I don't know how to do it, but I know it's easy and don't want to look like a dag for asking' look. So I asked him,

Tutor: Hey Bud have you finished?

Student: No.

Tutor: Then what's wrong?

There was silence.

Tutor: Well how about we get some work done? Let's do the next problem together.

4. Assignments based on journals

The journals were also a resource for assessment. Three assignments asked for a critical and personal reflection on the events in the peer tutoring sessions based on the journal. For each assignment a focus was provided, with questions to facilitate the writing. The first assignment guidelines were:

Assignment #1 (10%) 800 - 1000 words

Examine your peer tutoring experiences for the first two or three sessions. Use extracts from your journal to illustrate your points.

Use the following questions to structure your writing:

(i) What general impressions have you made so far?

(ii) In what ways have you established a working relationship with students, and with the teacher?

(iii) To what extent have your expectations of peer tutoring been met?

(iv) Think of one peer tutoring session that you remember as being particularly successful or having problems. What were the features of the session that contributed to this perception? Factors to consider could include: was it the difficulty of the topic, the attitude of the students, your knowledge of the topic, or another factor? Discuss one of these features in more detail.

(v) What topics have you tutored in so far? What did you notice about students' knowledge in that area? What misconceptions does one student, or the general group have? Were these similar to ones you had at that age?

(vi) What difficulties are you experiencing and how do you think you

might resolve them? (E2111 Study Guide, 1997: 5)

For most students it proved a worthwhile approach, and achieved its intention of allowing peer tutors to examine and reflect on differences people see in situations. The assignment structure supported further reflection of tutoring experiences, stimulated by the ideas in the unit reader. By asking tutors to share extracts from their journal, and by modelling (by reading aloud selections) of what can be included in a journal of this type, tutors gradually developed reflective skills.

The extracts below illustrate an appropriate blending of reflection on personal experience, which is linked to the work of relevant authors in the field and demonstrates a balanced view of the role of the tutor:

The students often perceive science to be a difficult subject, they see it as a special sort of thinking that is different from common sense reasoning (Driver et al 1994)... one student knew science as learning 'enough to pass' but not for interest. Their focus is also on content, they rarely relate to science as a discourse and understanding how science is constructed and transmitted (Driver et al 1994). Thus, although science is something they learn at school, outside of science careers they don't see the relevance of it in their post school lives.

Students' attitudes to science I believe is[sic] generally positive in the classroom. Most students do find the work interesting even though they do not appreciate its usefulness. Therefore as a peer tutor I tried to help the students appreciate how useful science can be. I presented some students with everyday scenarios where science knowledge would be necessary. Also with some students, they challenged me to tell them how certain careers need science. For example, I had difficulty when one student asked me how an upholstery (furniture coverer) worker could need science. Also, as the students don't appreciate the range of careers available I tried to present a range of the available careers including indoor and fieldwork and tried to relate them to their own interests. However I don't believe with many of the students that I was able to convince them that being a 'scientist' was an interesting job

to have.

The idea of self-fulfilling prophecy suggested in Good (1980) I feel is very important in the school situation. If a teacher has low expectations of ... students these are destined to 'rub off' on to the students to give them a less positive attitude and result in low results and effort by the students. Even a well-meaning teacher can unknowingly act in a manner which fulfils low expectations of a student. Factors such as selective attention, interpretation of a situation and differential teacher conclusions and behaviour. In a complex and constrained classroom it is sometimes hard not to give some students less time than others... One example happened with a student who generally doesn't seem to grasp the science ideas too well. At one time when he asked the teacher a question about an organic chemistry model he had made, the teacher, who had little time, gave him an explanation then said 'So, you've got it now, right?' The boy just nodded, though I could tell he was still unsure of how two molecules of the same formula, but different structure, can be different molecules. So I went over and we went through the explanation together so he could better understand how isomers worked, we were able to find other example too. This is how easy it is in a hectic classroom for lower achievers to get less time and therefore have less positive attitudes about themselves. Although it can work in the other direction, where a teacher concentrates on the lower achievers, forgetting those who grasp ideas quicker and easier.

5. Examinations

To encourage students to view their personal journal as a valuable tool, the 3 hour examination was 'open book' style, with students permitted to take in up to 10 pages of their journal. Many of the questions asked for an integration of the substantive side of the unit with the experiential, and the journal was able to prompt students' recall of their experiences. Responses required a knowledge of the views and arguments from the papers in the unit reader, and asked for

these ideas to be evaluated or applied to the particular experiences of the peer tutor.

This sample question demonstrates the links between personal tutoring experiences, and the substantive content of the course:
People behave in characteristic ways in groups. What are some of the roles they take? How are these roles productive or unproductive towards group processes? Describe at least two ways that students in one of your peer tutoring groups adopted one or more roles. Do your experiences support the view of those in your Reader?

Evaluation of the use of journals for science communication

Peer tutors' views

The value of the self reflection process was confirmed by peer tutors' responses at the end of unit formal university Unit Survey Systems Student Feedback. Among other questions, it provided data on students' perceptions of two of the key aspects of the unit (see Table 1). Students were able to see the integration of the journal with the set readings, which were supported by the lectures; for most the unit had a definite ability to help them develop skills in solving problems such as interpersonal and educational; this was further supported by a clear rejection of the unit as a memory unit, but as one that required critical thinking and reflection rather than rote recall; and finally, a unit that provided the opportunity for intellectual growth, perhaps due to its very different approach and format than more textbook oriented and fact based units.

FOR TABLE 1 CONTACT THE AUTHORS

The opportunity workshops provided to share experiences with other peer tutors was also highlighted by peer tutors. In the years prior to the

unit being offered, the tutors had little opportunity to interact with each other and thus had not been able to provide mutual support.

Seminar sessions included group building exercises as an important part of the programme. Many students commented positively on this aspect of the unit in the evaluation survey:

Reflecting on what has happened in the classroom and being able to share experiences with others, as I have been tutoring for 2 years.

Swapping tales with other students. This helped me help my students.

Meeting people who were like-minded and hearing their experiences in class.

Others commented on specific aspects of communication:

... improving my ability and confidence in using the skills that had been presented during the unit. In particular with group interactions; in assisting students to interact more successfully in groups and to be able to adopt different group roles during interaction.

Additional ideas in strategies of communication etc, which can be used in a class with young people or adult peers in other group situations.

Developing problem solving/analytical skills.

I realise I need to work on my own listening and communication skills as both the readings and peer tutoring experiences have given me a starting point.

A majority of students were very positive about their interactions with the students in schools. Over half of the tutors mentioned this as one of the two most beneficial aspects of the unit for them:

Interaction with young people, through a sense of satisfaction in assisting/helping/supporting and being friends with a group or individuals who may need it.

The actual contact and involvement with the school students and teachers was great.

... meeting some fantastic school children and seeing them progress.

One downside was the students' frustration due to their perceived lack of control over the situation in school classrooms. Their reflections have made them more aware of the possibilities for tutors to make a difference to student learning and appreciation of science. To this end they have become critical of teachers' lack of knowledge about how to use tutors well in the classroom, for example,
[need to improve] help provided to the Link Teacher. Give them a list of examples of ways in which the Peer Tutor can be 'used'.

The theoretical knowledge gained was not able to be applied to the classroom. Better communication between teachers at the school and the lectures could help this. This may also be effective if schools without rolling timetable could be found so that we can stay with the same classes allowing us to build a rapport with students.

Future course refinements include an information pack of suggestions for teachers outlining the aim of peer tutoring, and how best to use a peer tutor in classes.

Participating teachers' views

Participating teachers awarded a simple 'pass/fail' assessment for their peer tutor, and completed an evaluation through 8 questions (see Table 2). All tutors 'passed' the school component of the unit, and teachers responses are mostly very positive about the success of their tutors. Particularly high responses were for the peer tutors' abilities to listen to students, and their ability to work well with the teacher.

A few teachers stated they felt their peer tutor did not actively promote science as a career, but others reported that tutors who organised excursions to the university did have significant positive effects on tertiary bound students to consider science options.

Comments from both peer tutors and participating teachers highlight the different interests and needs of the tutors. The journal was an effective strategy for these needs to be met. It allowed for the individuality of the tutors and their contexts - working with set classes regularly, working without prior advice in any class that wanted help that day; indoors in a computing laboratory, or outside in environmental education activities; even working in subjects that were not the field of study of the student, such as tutoring in lower school biology when the student was in physics at university.

FOR TABLE 2 CONTACT THE AUTHORS

Views of participating teachers on success of peer tutor (N = 21)

Some comments, for example,

... initially lacked confidence to interact with the students, however, this improved over time. Her attitude towards science and the student was very positive.

... developed a strong empathy for the students who were willing to work alongside her in propagating and planting plants.

... she established and displayed some sound communication skills.

... is very useful and wise utilisation of resources . It gives valuable insights and therefore focus and goal setting for our students

... [her] approachability has assisted in this aspect. Her keen enthusiasm to organise a day trip via a swamp collection and lab analysis has ensured students will consider courses.

Journals, and assignment structures were modified to give greater choice in the focus to accommodate peer tutors' different tutoring situations. Continuity with classes appeared to be a critical point, however, and those tutors who enjoyed their peer tutoring the most were usually those who had been able to develop a longer term relationship with classes. Other successful programmes for credit have limited the number of schools involved and have concentrated tutors in a few schools (Jones, 1995).

Teacher feedback verified, to some extent, tutors' comments about what was happening in their tutoring experiences. For example, concerns about sometimes insufficient communication between the tutoring organisers and the school personnel appeared in both student journals and participating teachers' feedback, both of whom appreciated the need for clear outlines of expectations and goals of the STAR programme. Such recognition confirms belief in the need for open communication, one of the key unit objectives.

Enhancing the quality of journals

In the first year the unit was offered, a high proportion of the peer tutors experienced difficulty in comparing the ideas in the unit reader to their own experiences, and integrating these into their journals. Subsequently, more time has been given to modelling critical and reflective journal entries in the workshop part of the sessions.

Specific discussion on the ideas in the articles in the unit reader has been structured, and small group sessions set to evaluate the relevance, accuracy or inappropriateness of various authors views

included. This technique assists those peer tutors who need support to move from a 'descriptive' to a 'reflective' journal style, in which they not just describe the class and the topic, but analyse their part in the class, examine their influence on students, and tease out influences and reasons for students to behave as they do, not merely describe how they do behave.

Three dimensions of the self reflective process

Students were able to give evidence of personal communicative development in three dimensions: personal, science and social. It is felt that students, while developing skills in science reflection in their undergraduate courses about science experiments, do not have the opportunity to develop the social and personal dimensions of the scientist, who is not divorced from the more abstract and objective view of science still traditional in the pure sciences.

Personal communication

One of these ways was to ask students to reflect on the way they interacted with students - the social dimension:

As a peer tutor there are several ways that I could improve my interaction with students. This would include improving my ability and confidence in using the skill that have been presented during the course. In particular with group interaction: in assisting students to interact more successfully in groups and to be able to adopt group roles during interaction.

After several other questions she understood from her own explanations why the ... This is also a good way to build their confidence about what they already know. As a peer tutor I find I have more opportunities than the teacher to interact with the students on this level as the process can take some time ...

Another was to encourage students to view and use the readings as a way

to enhance their reflection, and some journal comments indicate success in this:

The contact with the students was the most satisfying part of the course because you can actually experience what the readings inform you about.

In their journals, students were able to examine the complexities of interpersonal communication. For one student, her observations of the interaction between two high school students, and her intellectual appraisal of it due to her readings in the area, demonstrates a very perceptive aspect to her ability to 'read' interpersonal dynamic situations. Such skills are highly sought after by employers:

I think this session really taught March and Mile to think before they develop their opinion. Marcus may learn to respect other people's perspectives, learn the skills of negotiation and mediation, and be aware of ways to reach a consensus (Hill and Hill, 1990). For Mike, he may learn that having different ideas does not mean he is wrong, but different people have different ideas depending on one's exposure and reasons. As in Piaget's Theory (Renshaw, 1992), such development of thinking was driven forward by cognitive disequilibrium, caused by disagreement between peers.

The personal dimension is an aspect that was frequently commented on by students, who found the discussion based and interactive workshop approach very successful:

Especially important is the time spent talking about your experience with other [university] students - otherwise at times it is easy to lost motivation and confidence.

I liked the workshops. They made me feel better after discussing with other [university] students the types of concerns I had. They allow interaction with tutors and other students.

Part of the personal dimension was to organise an excursion to the university, or for those students who were also working off campus, to their workplace:

I enjoyed my classroom sessions and have developed a good rapport with the students in general. I also found the excursion to my workplace a fulfilling exercise.

Science dimension

The science dimension of the unit had effective science communication as its goal. Students' journals provided evidence that they were considering different ways of presenting information, in particular taking the needs and interests and skills of their audience into consideration. This next extract demonstrates how this student reflected her increasing skill of science communication, in her ability to 'read' her audience, and tailor her interaction with them:

The students were asked to imagine they were a flower and to write a story of their life. This caused problems as many of the student were confused about the aims of the activity - writing prose in science! However I realised it was to stimulate the students to reflect on their learning of flowers and to apply the knowledge within a more realistic setting - a live flower in a garden. Many of the students asked for help and because there is effectively no entirely correct or wrong answer this left a wide scope for students to construct the story from their own knowledge. Therefore it was effective to use questioning got teased out students' ideas about flowers.

Students' journals indicated strong development from the transmission mode of learning to a more effective question and reflection mode. An extract below demonstrates how the student has taken on-board the ideas of Elstgeest (1985) about the value of teaching understanding through questioning, and reports a successful interaction with students learning about ions. The act of journal writing has allowed him to reflect on the encounter, and hold onto this belief, and has the potential to facilitate his use this technique when trying to explain

to his own future work place staff or colleagues, for example,

Breaking up questions when answers are too complex into ones concerning about relationships so that they are able to find out. I have found that by questioning I was able to make a student understand about ion charges. By referring him to the periodic table and asking questions about the valency, he was able to understand that the charges relate to the position of that element in the table. I think I was successful by using questioning techniques to make students understand something instead of just telling them straight.

Social dimension

One student found the theoretical consideration of group dynamics and changes over time (MacCallum & Macbeth, 1996) to be of assistance with a high school group:

A group of 12 boys that I visit weekly, we would reflect on the experiment that we would complete. Through the reflection and discussion the group would always come up with the answers to the questions in the book, I feel the reflection process has moulded this group to depend on each other to complete work and understand concepts. Through my aid, I have enabled the group to talk about the problem and express their views more confidently. This also aids the peer tutor in the way the students begin also to depend on you and through this you can help them more since they appreciate your time with them.

Comments of this type would almost never be asked of students in mainstream science content units, and it is understandings of these, that relate to a personal, social and science dimension that demonstrate the value of the self reflective process within peer tutoring courses.

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