

THE STUDENT PERSPECTIVE IN DEVELOPING GRADUATE ATTRIBUTES THROUGH PROBLEM-BASED LEARNING IN FIRST YEAR AGRICULTURAL SCIENCE

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KEYWORDS: graduate attributes, problem-based learning, student perceptions, learning journals, generic skills, agriculture

ABSTRACT

To meet university proclamations, academic staff are required to include graduate attributes in student learning. The approach adopted in this first year agricultural science course was to utilise problem-based learning to develop discipline knowledge and graduate attributes in a seamless manner. Rather than giving the students a questionnaire with options for students to indicate what graduate attribute they had learned, a structured learning journal was used to question students about their learning without specifically asking about any graduate attributes. Analysis of the learning journals revealed that significant numbers of students perceived that they had learned or practiced a range of graduate attributes, including teamwork, research, personal attributes, writing abilities, time management, problem solving, leadership, and multidisciplinary skills. These student perceptions exceeded the teachers' expectations and revealed that problem-based learning in teams can be used for learning discipline knowledge and developing graduate attributes.

Proceedings of the Australian Conference on Science and Mathematics Education, University of Sydney, Sept 29th to Sept 30th, 2014, pages 170-175, ISBN Number 978-0-9871834-3-9.

INTRODUCTION

Graduate attributes are the generic qualities developed by students while at university and they have been defined as: "the qualities, skills and understandings a university community agrees its students would desirably develop during their time at the institution and, consequently, shape the contribution they are able to make to their profession and as a citizen." (Bowden et al., 2000). This definition indicates the general nature of graduate attributes and that they may be specific to particular university communities, which are usually formed around disciplines. Different universities describe their graduate attributes in various ways and they can be difficult to teach and measure because of the range of conceptions expressed by institutions and individuals (Barrie 2004, 2006). There is also uncertainty as to the attainment of claimed generic attributes of graduates (Barrie, 2005). Despite this general vagueness about the meaning, teaching and acquisition of graduate attributes, the Australian Universities Quality Agency has expressed the desirability for monitoring and grading graduate attributes in higher education (AUQA 2009).

To clarify understanding of graduate attributes amongst the academic community, Bennett, Dunne and Carré (1999) and Barrie (2006) have derived models or patterns from studies of academic conceptions. The former authors identified four groups of comprehensive generic attributes (42 individual items) that apply to any discipline: the management of self, others, information and task, and related them to disciplinary content, disciplinary skills, workplace awareness and workplace experience. Their analysis of academic practices gave six patterns of course provision in relation to generic skills, the discipline and workplace. For example, Pattern 2 is concerned with discipline knowledge and the acquisition of specific generic skills, and Pattern 6 includes an emphasis on 'real-world' experiences in the workplace. From an analysis of interviews with academics, Barrie (2006) concluded that there were four broad graduate attribute conceptions amongst academics that increase in complexity from students having a basic set of abilities to which discipline knowledge is added (level 1) to level 4 where scholarly learning can transform disciplinary knowledge and the individual. These authors illustrate that there is a broad range of academic conceptions and course practices in relation to the development of graduate attributes. Furthermore, the categories given for course provision and academic conceptions allow an appraisal of academic intent in declared course objectives and outcomes.

There are relatively few publications concerned with the student perceptions of graduate attributes and how they believe the attributes have been acquired. Tapper (2004) interviewed agriculture students who perceived that they developed critical thinking in the context of literature reviews but generally did not relate the ability to other circumstances. Oliver, Herrington and McLoughlin (2000) used a survey and interview technique to ascertain from first year students how well they perceived that they had practiced and developed the graduate attributes given by Bennett, Dunne and Carré (1999) in a problem-based online learning environment. The students felt that they had practiced and developed most of the 40 attributes tested. These papers illustrate that the graduate attributes can be developed within the learning context rather than being taught separately and that the students may be aware of them and what they are learning. This current paper reports on graduate attributes within the discipline context (not taught separately) primarily from the perspective of the students as well as the course teacher in agricultural science.

Problem-based learning (PBL) has often been advocated as supporting the development of a wide range of graduate attributes as well as discipline learning (Oliver, Herrington, & McLoughlin, 2000; Oliver & McLoughlin 2000; Major & Palmer 2001; Edwards, 2005). These authors note that PBL promotes the learning of theory and content as well as generic skills such as problem solving, critical thinking, teamwork, and communication skills. This paper is concerned with the use of problem-based learning to teach discipline material as well as develop graduate attributes and examines the outcomes mainly from the perspective of students. The student perspective and conceptions of their learning were derived from analysis of their learning journals, and these were compared with the original teacher intent.

METHOD

COURSE AIMS AND INTENDED OUTCOMES

The previous course, 'Agricultural Science 1B' was teacher-centred and based on traditional lecturing methods. Student unit of study evaluations indicated that students lacked motivation and learning was not always effective. The unit was fragmented with distinct components (e.g., plant physiology, soil science, crop management) that the students did not relate to agricultural practice. A new course in 2008, 'Climate and the Environment' introduced PBL primarily to motivate and engage students to promote deep learning. The course designer and instructor (Daniel Tan) had the twin aims of the students learning discipline material concerned with farming problems in the rural environment and developing contextual student generic skills. The original intention was for the first year students to develop skills in problem identification and teamwork, conduct research using online scientific databases, provide plausible solutions to a complex problem, and write a scientific report with the correct referencing style. These aims correspond to Pattern 2 of Bennett, Dunne and Carré (1999) which is concerned with the development of discipline knowledge and specific generic skills in context. The conceptual approach taken by the teacher also corresponds with Barrie's (2006) Level 4 "enabling conception" where the development of the graduate attributes is seen as interwoven with the disciplinary learning. The generic graduate skills are intended to be transferable to other units of study, the workplace and life generally.

COURSE STRUCTURE AND LEARNING ACTIVITIES

The 12-week course in 2008 'Climate and the Environment' was a core first year unit for four degrees: Bachelor of Science in Agriculture; Bachelor of Animal and Veterinary Bioscience, Bachelor of Horticultural Science and Bachelor of Land and Water Science. The 113 students in the cohort were allocated to mixed groups (small online groups and larger face-to-face tutorial groups) therefore providing the opportunity for cross-disciplinary and cross-group interchange. The unit allowed the students to discover how climate influences the biophysical and biotic environment and how this affects rural production, native and domestic animals, crops and pastures, native vegetation and pest populations; it also highlighted the importance of physics in solving problems in relation to climate and rural production.

The components of the course and their assessment proportion were: formal examination (50%); laboratory work (15%); workshops (10%); problem-based learning (PBL) project (20%); and reflective journal (5%). The PBL project was intended as the main means of developing and practicing the generic attributes. The PBL project (beginning in week 5 with weekly activities) was concerned with kangaroo and sheep farming and was highly topical with regular media reports during the time the students were engaged with the learning activities. For the PBL project the student activities included the preparation of a consultancy report by conducting research (e.g. internet and Web of Science) on

various aspects of the problem and contributing to the online discussion forum and face-to-face class discussions. A submitted draft consultancy report from each student received feedback from course tutors prior to a final submission at the end of the semester. The reflective learning journal was also submitted near the end of the course.

ASSESSMENT OF DISCIPLINE AND GENERIC ATTRIBUTE LEARNING

The discipline assessment criteria on the final individual report were within the context of the problem-based learning and required a description and discussion of the various components (physical, environmental, biological, economic, production, and ethics) as well as the definition and justification of the problem and management recommendations to address the problem. Marks were distributed between the components and problem issues.

An analysis of the learning journals allowed the assessment of generic attribute learning from the perspective of the students. The learning journals were structured with the following 10 questions.

1. How do you feel about working with your team?
2. Are your team discussions useful to your team's progress in this exercise? Why or why not?
3. Were there some comments made by your team members that made you think differently? What were they, and how did they make you modify your thinking?
4. What motivates you to learn through this exercise?
5. How have you changed as a learner through this exercise? Give examples.
6. Have you learned anything about "how you learn"?
7. What obstacles did you face in completing this exercise, and how did you overcome them?
8. What are some of the strengths you have demonstrated in this exercise?
9. Are you satisfied with what and how you learned through this exercise?
10. Do you think your learning through this exercise helps you in your field of study?

Comments made by students regarding graduate attributes were unsolicited as none of the learning journal questions specifically asked about them. This approach to identifying student perceptions of learned or practiced graduate attributes is markedly different to students completing a questionnaire that lists the graduate attributes and allowing the students to select from given choices, such as administered by Oliver, Herrington and McLoughlin (2000). Moreover, the graduate attributes were not the governing criteria used to analyse the text of the learning journals. The text responses to the questions were qualitatively analysed manually by a three-stage approach. The first stage involved reading of the responses to enable categories of responses to be created (categories such as: multiple perspectives, research). As practiced in a variety of qualitative research methods, a thematic analysis was undertaken so that the categories could be created from the text responses themselves rather than imposing a set of pre-ordained categories. The second stage was to find typical expressions (quotes) from the respondents that would illustrate and confirm the categories. The third stage was to identify graduate attributes of any kind as expressed by the students within the original categories identified, and these are reported here with quotes as examples. This approach allowed the student perception of graduate attributes learned or practiced to be identified independently from the teaching intent.

RESULTS AND DISCUSSION

The data presented here are entirely from the perspective of the students as given in their learning journals. The teacher's intent is noted above, and the outcomes are a product of the authentic PBL challenge and circumstances that allowed student autonomy within the group-learning environment.

STUDENT PERCEPTIONS OF GRADUATE ATTRIBUTES LEARNED AND PRACTICED

The graduate attributes that the students revealed in their journals (104 in total) were:

- Teamwork skills
- Research skills
- Writing abilities
- Personal attributes
- Personal development
- Time management
- Problem solving
- Leadership
- Multidisciplinary skills

The development of *teamwork skills* and learning through different perspectives of team members (e.g., noted by 33% of respondents to question 2) is the most commonly mentioned of the graduate attributes. For example:

...working in groups allows for an easier way of gathering opinions and being able to understand various aspects of one idea... I probably wouldn't have been able to think up some of the ideas that other people thought of and it really helped to expand my thought process and apply concepts to real-world circumstances.

I feel that working in a team is an essential part in life and that it is a skill that needs to be learnt... I also felt that I learnt a lot more than I would have on my own due to the contributions of the other team members.... It gave me a chance to learn to accept people's ideas even if I didn't totally agree as everyone has a different opinion.

Students commented that the quality of learning and the development of other skills were improved as a result of teamwork, e.g.:

It allowed for a greater understanding of the presented problem and through teamwork I have managed to write a much better report than I would have if I had been working on my own.

At some times in life we have to work in teams and the team discussion board will and has helped me and others to practice these skills. I think that teamwork develops the qualities of helping others, being patient and open minded to other opinions. These qualities are key attributes that employers search for when interviewing potential employees.

The contribution of various ideas from team members was also of great assistance in gaining a broader outlook on the issue...As I mentioned I usually prefer to tackle assignments individually. Yet this co-operative approach was an enriching new learning experience.

Research skills were practiced constantly and mentioned by almost every student (96% of students used the word 'research' at least once) in a variety of contexts, and particularly in the recognition of developing arguments supported by research, e.g.:

All the members that contributed to the discussion had valid points of view which were mostly backed up by journal articles.

Collaborating ideas and research with one another allowed me to get a deeper understanding of the topics in order to discuss them in my paper...I feel that I contributed very significant research to our discussions.

It is also motivating in the sense that if you have an idea, have it backed up by research and are sure about its relevance, you are able to defend it against another idea held by someone else in your team.

Writing ability was perceived as an important attribute (e.g., mentioned by 27% of people in response to question 8), particularly in a professional context, e.g.:

I also think that it is important to learn how to write sophisticated consultancy reports as it is likely that we will have to write lots of them when we enter the workforce.

My writing skills on the discussion board are one of my strengths. I am able to express myself through writing and lay down evidential fact with some ideas of further research areas.

Through the group work, several students expressed the development of a range of *personal attributes* including better listening, collaboration and communication skills, e.g.:

By working with a team, one of the major changes I have made as a learner is being able to open myself up to new and differing opinions rather than simply focusing on my first reaction to the issue.

I changed from being just a listener to being both a talker and a listener. This change has helped me learn through this exercise as I was not as timid as I usually am and was able to voice my opinion and receive feedback.

In addition to personal attributes, the students also included wider aspects of *personal development*, such as being more open-minded, the ability to change personal beliefs and attitudes, and acknowledging different points of view that may also be evidence-based, e.g.:

This was seen with my initial view of being against kangaroo farming with no actual knowledge of the problem just my personal feelings. Then after collecting all the evidence and becoming informed on the problem I was able to understand that kangaroo farming is a viable and feasible option to solve the problem.

Before beginning this PBL I was a very close minded learner and I valued my own opinion more than that of others....I think I am now more open to the opinions of others as I have seen that they can actually broaden your own understanding.

The management of self is one of the key groups of generic attributes given by Bennett, Dunne and Carré (1999), and that includes effective management of limited time available. The problems of time and time management were often mentioned by the students (e.g., 21% of respondents to question 7) and some students gave strategies for managing their time in their individual circumstances, e.g.:

As mentioned earlier, another obstacle I faced common to all assignments I complete was that of ineffective time management skills. This was overcome by writing each section of the report as the topic of discussion for each week was undertaken by my group.

The main obstacle that I faced when completing this task was the one of time management... To overcome this problem I worked out a plan that I could follow and set aside particular times in which I would complete the work.

A part of problem solving with an authentic complex problem is the identification of the problem that is to be solved (Boud & Feletti, 1997; Savery & Duffy, 2001), and several students made the observation that this was not an easy task in relation to sheep and kangaroo farming, e.g.:

In this particular exercise I found it difficult to define the problem that was at hand. There were so many angles that this report could have taken and it was difficult to determine which was the most important one to me.

Largely the obstacles faced in this exercise were the initial vagueness surrounding the problem definition and sourcing of the information. These were both overcome through group work...

However, many students (e.g. 29% in response to question 10) mentioned that they had developed or practiced valuable problem solving skills and several noted that this required the combination of a range of skills, including teamwork, research, communication, and a multi-disciplinary approach e.g.:

Exercises such as this demonstrate the need for teamwork in identifying and solving problems I may face in my field of study. They also demonstrate that initial problems are not always as they first appear, further research and study may need to be undertaken to find the real problem.

I feel that it gives students an idea of the problems they will face in the future as well as give confidence in deciphering problems in the context of science, agriculture as well as contemporary Australia.

Geographical and geological, legal, technical, economic and business issues were identified and addressed, which [were] researched and integrated into the solution to the problem.

While teamwork was widely acknowledged as a skill practiced during the problem solving abilities, a few (6% of responses to question 8) students indicated exercising *leadership* skills. This seems a realistic self-appraisal since by definition relatively few people would actually be leaders. Example quotes are as follows.

Some of the strengths I demonstrated in this exercise I think include the way I was able to provide a good sounding board for the ideas of my group members in our group discussions and help them develop their own ideas better.

Brainstorm and leadership. As an university student, everyone has certain capability to

solve the problem by independent research, learning from media and find the answer, but sharing the idea and leading the team to success is quite different from learning

Some students (20% of responses to question 10, for example) observed that they were practicing and developing interdisciplinary approaches, or utilising the perspective from many disciplines to problem solving, e.g.:

This research task incorporated many different ideas that span across my course of study, including animal management, environmental factors and precautions such as greenhouse effect and land degradation from natural and unnatural factors and their implications on the future for farmers and Australia's landscape.

This assignment covered a broad range of issues to do with the sustainable management of our fragile environment and limited natural resources. This included considering past and present land uses, the biodiversity of ecosystems as well as taking into account social, political and economic issues alike.

I touched upon medicine, geology, economics and marketing. All of these subjects I have studied to a limited degree but have not until this point had the opportunity to draw it all together.

CONCLUSIONS

From an analysis of structured learning journals that did not question students specifically about graduate attributes, it was clear that first year students perceived that they learned or practiced a range of graduate attributes (including teamwork, research, personal attributes including personal development, writing abilities, time management, problem solving, leadership, and multidisciplinary skills) while engaging in authentic problem-solving activities as groups in online and face-to-face environments. The students learned and practiced a range of graduate attributes while learning about the discipline in a seamless manner. In this learning context there was no need to teach graduate attributes separately; indeed that would have been irrelevant, superfluous and lacking in contextual meaning. The students perceived that they had developed collaborative teamwork skills and advanced research skills. Analysis of the learning journals has demonstrated that first year agricultural science students are more than capable of critically reflecting on their own learning.

ACKNOWLEDGEMENT

The educational designer, Ole Brudvik, is gratefully acknowledged for his contribution to the structure of the problem-based program and creation of the structured reflective learning journal for the students.

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