INTEGRATION OF PROJECT MANAGEMENT SKILLS TO MANAGE A FOURTH YEAR RESEARCH PROJECT

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ABSTRACT:
Civil engineering students at the Cape Peninsula University of Technology generally find the final year research project very daunting. In most cases it is the first time that they are not 'learning' passively by sitting in lectures, receiving notes and worked out examples, memorising the material and then writing an examination to demonstrate their 'competency'. Suddenly learning comes by doing, and they are faced with the challenge of executing a significant research project. For students who do not have good management skills, this becomes a very difficult task. To address this problem, staff have, over the past decade, integrated project management with the research project to the extent that it has now become one subject with two final year credits. This means that students learn how to use project management skills to manage the research project, which runs over one year. Project management skills integrated with a rigid structure, complemented by lecturer support in a web-based e-learning environment, has been developed to assist students in completing the research project. This has proved to be very successful and students have commented that without the newly acquired project management skills, they would not have been able to complete the projects on time. The results indicate that the integration of project management skills can relieve the role reversal entrapment problem. However, interventions to prepare the students more adequately must be considered over the first three years of study. .The paper presents the historical background to the problem, an overview of how the revised methodology is being implemented, and it indicates how e-learning is used to manage the course.

KEYWORDS:
final year research project, e-learning, project management.

INTRODUCTION

Final year engineering students at the Civil Engineering and Survey department of the Cape Peninsula University of Technology (CPUT) are not adequately prepared for immersion in the research project which forms a compulsory component of their course. The issue addressed in this article comprises one particular feature of educational programmes consisting of taught and research components, namely that students become trapped at the research threshold after having successfully completed the course work. From discussions with the students it becomes evident that students find the final year research project by far the most difficult programme to manage. However, considering the way undergraduate subjects are generally presented and taught, it is not difficult to see why. Traditionally, universities have mainly taught content and concentrated on optimising the efficient presentation of knowledge, thereby overwhelming the students with far more than they could possibly absorb. Thereafter, the knowledge is invariably retained only long enough to enable the successful completion of an examination (Pearce, 2005).

The perception exists that the fundamental cause is a role reversal in the taught versus research milieu. In the taught milieu it is possible for the student to remain a passive, reactive partner for almost the entire process – the syllabus, timetable and work programme are all dictated by the institution. This is reversed in the research milieu, where the student is required to take the initiative in all of the above (Slatter, 1998).

Concerted efforts have been made to improve the situation, so that more learning can take place in the first three years of study (Slatter *et al*., 1997; Haldenwang, 1998). However, students are generally not prepared for the daunting task of what the research project requires of them. For many it is their first introduction to research. Although they have solved engineering problems in their other undergraduate work, these problems were generally well defined and of closed form - a problem for which there is a single, definite answer. For example, they were only required to follow a sequence of steps in a design protocol to get to an answer. Now the situation demands that they have to go out and identify a researchable problem, find the relevant literature, design an experimental procedure, and build a facility if necessary. In addition, they have to perform the test work, analyse the data which may sometimes require some software development, and document the process in an acceptable manner. The analysis of the data also requires a higher level of comprehension than in earlier courses.

The literature does not seem to offer a solution to this problem. 'More-of-the-same' – exposing students to more taught courses such as research methodology is unlikely to assist them in coping with the problem of role reversal. It is serendipitous that the very same students have studied elements of project management from their first year.

The project management skills that students are exposed to are conducive to creating a manageable environment enabling them to achieve their objectives. Furthermore, this assists them in the judicious management of time and resources, as well as exposing them to risk management. Regular reports also ensure that students achieve their scheduled research milestones.

Students seem to experience high levels of stress at the beginning of their 4th year when they have to commence with their research projects (Pearce, 2005). It is important that this condition be addressed to ensure that the research project becomes a positive learning experience.

Therefore the paper addresses the research threshold that students become trapped in during structured course work, the way in which most of the learning takes place over the first three years.

The objective of this paper is to present an innovative solution to this problem, whereby the hitherto separate subjects, Project Management and Research Project, are combined. A structured link between these somewhat diverse discipline areas has been created, providing the requisite learning support, and improving success rates.

The way in which this is accomplished is by:

- Creating a structured environment using a web-based e-learning environment;
- Providing mentors;
- Introducing research methodology, and
- Developing students' project management skills so that they can manage their research reports.

These measures provide a 'safety net' environment which serves to solve the entrapment and role reversal problem in a practical and structured way.

BACKGROUND

The Cape Peninsula University of Technology evolved from the merger between the Cape Technikon and the Peninsula Technikon at the beginning of 2005. The two campuses, both in Cape Town, are geographically about 20 km apart. The merger was the result of a political intervention, which resulted in the formation of a new institution with a combined student population of about 25 000 (South African Government Gazette, 2001).

Both former institutions were similar to the Polytechnics found in the United Kingdom and the Fachhochschule in Germany. During the early nineties the institutions launched degree programmes in accredited fields of study, including engineering. Furthermore,

post-graduate research has since then commenced.

When the degree courses were started, a research project was introduced at 4th year level to enhance the 'degree worthiness' of the new course. As the curriculum did not offer a suitable subject for the research project, the latter was linked to an existing subject called Project Management. This was necessary as curriculation has been controlled at a national level and thus the introduction of new subjects was prohibited. Although the subject was named Project Management, it consisted of the research project component (70%) and the project management component (30%).

Throughput in academic offerings with a research component is a perennial problem (Slatter 1999a). The introduction of concurrent project management input to help manage the research project has greatly increased the prospective throughput of the students from about 60% in 2003 to 80% in 2005.

LITERATURE

Today's students will function professionally in what has been described as the 'knowledge society', and Jarvis (2001;2003) has analysed the changes which lead to, and characterise, this new age. Lifelong learning is now a prerequisite for the economic survival of society. The notion that education and training occur during adolescence and are solely a preparation for, and separate from, life and work, has been overturned within less than one generation. There is a growing focus on qualities such as learning to learn, self-management and self-confidence, negotiation and critical thinking. The skills of collecting and interpreting information and using knowledge in all its forms are a priority in a society that is, for the first time in human history, information rich. This has profound implications for higher education. Furthermore, Drucker (1993), states that the kind of knowledge concerned is not just any knowledge. It is knowledge that can be applied for results – knowledge that can be applied systematically and purposefully to define what new knowledge is needed, and to accomplish systematic innovation.

It is important to note that the acquisition of these particular skills is exactly the basis for formulating the Batchelor of Technology (BTech) research project in Civil Engineering at the CPUT, and provides, in general, the *raison d'être* for research as the teaching strategy of choice for higher degrees (Slatter,1998; 1999a; Slatter *et al.*, 1995a; 1995b; Slatter *et al*., 1997a; Slatter and Peterson 1997b).

Slatter (1998; 1999a), identifies formal tuition and research as the two learning modes prevalent in tertiary institutions. A widespread and non-trivial problem is bridging the divide between these two. On the one hand, there are students who achieve good grades under the formal tuition regime. They are drawn into higher degree studies and then flounder because they have not successfully adapted to the new mode of learning. On the other hand, there are supervisors who regard research as a task which is mechanically performed by students who are automatically expected to be good researchers on the grounds of their good performance at undergraduate level.

Arguably, the major difficulty here – for both the student and the supervisor – is the role reversal, which typifies the divide between formal tuition and research (Slatter, 1998). The typical undergraduate learning experience is not student-controlled. The student usually has little or no control or responsibility concerning timetabling, course structure, content and evaluation Students remain dependent on the lecturer to take responsibility and accountability for these issues. Within the context of a research project, this situation is reversed and the student must take the initiative for independent study and investigation. A simulation of true-life problem solving is thus realistically achieved.

It is also useful to view the subject of this article from an educational psychology perspective. A central thesis in the educational approach which underpins the BTech Project Progamme Slatter *et al*., (2004), is that learning through research is qualitatively different from learning through subject teaching (Slatter, 1998). Furthermore, as students engage with the research learning modality, the different forms and processes of engagement with knowledge enable students to make conceptual shifts. This acts as an unlocking mechanism or vehicle for allowing the development of skills needed for problem solving, critical thinking and communication to the sophisticated levels that are required. The research pertaining to this study is thus located in the 'students' experiences-of-learning' framework that prioritises learning from the learner's perspective (Martin and Säljö, 1976).

Perry (1970; 1988) reports a continuum of students' intellectual development, ranging from passive recipient to active agent in the knowledge producing process. Perry further argues that students can move along this spectrum through further study, if given the appropriate support.

The work of Marton and Säljö (1976) identifies 'surface' and 'deep' approaches to students' learning. 'Deep' students – who paid attention to argument and were focused on the underlying meaning – were not only able to articulate the meaning of what they had read, but also remembered details of the text better than those who had focused merely on 'surface' facts.

Slatter (2005) and Marton *et al*., (1993), draw attention to the dichotomy between reproductive and transformative students. Reproductive students conceive the purpose of their learning to be the reproduction of knowledge in an unchallenged and unchanged form. Transformative students view knowledge much more holistically. Knowledge becomes part of their understanding and worldview, to be closely associated with their personal and professional development.

This brief review of the broader debate indicates clear qualitative differences in student learning, and in the ways it is accomplished, which are highly relevant to this study. Role reversal, despite its particular pitfalls and challenges, must be bridged if the students are to take responsibility for their own learning. Only then will they be adequately prepared to perform as professionals in the knowledge society.

COURSE LAYOUT

The course 'Project Management and Dissertation 4' has been developed over several years and now constitutes 25% of the fourth year credits. Although it is one integrated course, it consists of two main parts, the one being the research project and the other the project management theory. The project management theory is taught as a structured course, which could effectively stand on its own. The textbook that is used is 'Project Management for success' (Knipe *et al*., 2002), which covers the syllabus adequately. This knowledge is then applied to manage the research project. Some of the aspects that are emphasised and taught are listed below.

RESEARCH PROJECT
- Research methodology
- Writing a project / research proposal
- Conducting a literature review
- Practical time management
- Presentation skills
- Writing a dissertation

PROJECT MANAGEMENT THEORY
- Project management context
- Project management cycle
- Project management for strategic goal achievement
- Scope management
- Integration management
- Communication management

Time management
Human resources management
Quality management
Cost and financial management
Procurement management
Risk management

The students are introduced to research methodology at the beginning of the year when they either have to find a researchable topic, or join a research group such as the Flow Process Research Centre (FPRC), where researchers make topics available to the students. The next phase is to prepare a proposal, which is evaluated by the research staff of the department. These early interventions help to assure that students acquire the necessary skills and have selected research topics that are practical and feasible. Members of the lecturing staff are designated to the respective students to assist them with the research process. This involves regular interviews and report back sessions with the students.

During this period the students are also introduced to project management topics as shown above. These skills are then applied to assist students in managing their projects in the course of the year. Some students have admitted that without these tools, they would not have been able to finalise a project of such magnitude within one year.

The course is managed by means of e-learning, using Web-CT®. This has led to a marked improvement in the effectiveness of communication between staff and students. Students use the facility to discuss matters of common interest on a discussion board. It has become clear that the integration of project management, in such a way that it facilitates active learning, is of prime importance.
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SUBJECT EVALUATION / ASSESSMENT

Project Management and Dissertation 4 is a continuous evaluation subject – which means that the final mark does not rest upon any formal and final examination. The subject consists of lectures, tests, assignments, reports, presentations, and a written dissertation. The assessment of the project management section is achieved through the evaluation of students' assignments and tests, a risk analysis of the research project, and five progress reports on the research project compiled during the year. The research staff then assesses the dissertation and a proforma is used to adjudicate marks. The draft dissertation is corrected so that the students can improve the final version of the research project with a sound knowledge of what is expected of a good dissertation.

Students also have to present their work to their peers and to lecturing staff by means of a poster presentation at the University's annual Civil Engineering Conference. These summary presentations of five minutes prepare them for a final power point presentation of 15 minutes, which is assessed. The mark allocation for the subject is tabulated below

Project Management:		
2 x Tests	50%	
3 x Assignments	30%	
Risk analysis	5%	
5 x Progress reports	15%	
	100% x 0.5 =	50%
Treatise:		
Proposal	10%	
Treatise	80%	
Final Presentation	10%	
	100% x 0.5 =	50%
		100%

It is vitally important to note that evaluating the process is at least as important as evaluating the final product.

LECTURER INVOLVEMENT

In the past the research staff were generally responsible for managing the research component. This meant that three staff members had to assist between 40 and 60 students. Support by staff involved finding of topics, marking the draft and final versions of the proposals, as well as the literature reviews

and theses. In addition to this, it also required dealing with all the intermediate problems related to the research.

The ideal has always been to involve the entire departmental staff cohort in supervising the students. High lecturing loads and a general reluctance of staff to become involved in research have previously inhibited this process. The integration of the two institutions into a technical university has changed this, and for the first time a large number of the staff have become involved in managing the research. Their involvement entails the following:

- At the start of the year lecturers are asked to provide research topics in their fields of expertise. These are made available to the students who then have to approach the lecturer and discuss the project before asking him / her to become his / her mentor for the year.
- The lecturer has to check students' draft proposals, making sure that the projects are feasible.
- When the proposal has finally been approved, the students are supervised by a specific lecturer responsible for between 2 and 6 students, and for arranging 3 to 4 weekly progress meetings.
- At the meeting, chaired by the lecturer, the students report on the progress of the previous month, as well as the proposed programme for the following month and any problems which have been encountered. The minutes are recorded by one of the students and distributed to the rest. These forums are very helpful to the students, as they learn from each other in a constructive way.
- The lecturer also screens all the sections of the treatise before they are handed in for final assessment.

These measures have assured that more students are supervised by lecturers with expertise in a particular field, whereas previously only a few lecturers had to oversee a large group of students.

This has proved to be a good form of intervention, as students encountering problems with their research are identified at a much earlier stage.

Students soon learn that they have to take the initiative themselves – staff is there to guide and facilitate – not to solve the problem. This is where the role reversal is most acute.

THE STUDENTS' PERCEPTIONS OF THE PROGRAMME

The following quotes from students constitute part of the responses to a set of exercises in Higher Order Thinking Skills that the students were asked to complete during the year. They provide invaluable insight into the problems that students experience when they are suddenly exposed to a different mode of learning. In the following two sections unedited quotes are presented. Each of the following sets of students self-reports indicate the contrast in the learning milieu that students experience. The self-reports are taken from a cross-section of the student-body, a number of whom are second and even third language English speakers.

STUDENTS SELF REPORTS ON EXPERIENCE OF LEARNING THROUGH SUBJECT TEACHING

DESCRIPTION OF THE SUBJECT LEARNING PARADIGM

'Subject teaching is the traditional way of teaching. For this method a teacher is required that possesses the required knowledge, experience and information about the subject. A set curriculum is followed with selected aspects of the subject being conveyed. The student is presented with this curriculum at the start of each subject and is informed of his/her requirements to pass the subject. It presents the students with a framework that forms his idea around the subject and contents thereof. It does not facilitate any extended thinking around the subject that might include more aspects and lead to a wider framework that the one designed. The student consults prescribed textbooks and no need to consult non-prescribed textbooks is created. The

information conveyed by the teacher is seen as correct and just and is not challenged resulting in the underdevelopment of critical thinking and reasoning.'

THINKING DEVELOPMENT

'Thinking skills are not adequately developed through subject teaching, this is because one tends to study for the 'right answers' and studying is confined, the brain works as a storage devise that only produce(s) stored information when requested to do so. Questions such as; "why and what if", are not part of the daily thinking because it is presumed that the information given by the lecturer does not need to be improved because that is what is going to be asked in a class test or examination.'

LEARNING APPROACH

'Subject learning is often linked to regurgitating information. In many cases the work and material is just recalled and not understood. Understanding the work is expected to occur as the student is forced to work through structured examples, this does not seem to incorporate that nobody learns in the same manner. Without understanding the student does not have value added learning. Students are able to study days before an exam and still do well, as it is easy to recall information in the format that the structured syllabus has defined.'

WORKPLACE PREPARATION

'When a student is tasked with solving a problem, he/she already has all the background information in order to correctly interpret the problem, and the given problems have one or a very restricted number of solutions. The student generally knows this and therefore only has to work towards that solution, using the information (tools) given to him... As far as preparation for the workplace is concerned, in the real world, the problems that the students will be faced with will be varied and the nature and scope of is often unknown or at least not always apparent. The student might be able to excel at tasks, when working in a position where a senior positioned colleague channels through information to him/her. The student will find it difficult however to work at a high position then that, as he/she is ill equipped to tackle any obstacles in unchartered territory.'

STUDENTS SELF REPORTS ON EXPERIENCE OF LEARNING THROUGH RESEARCH

DESCRIPTION OF THE RESEARCH LEARNING PARADIGM

'This is one of the trickiest ways of learning because you have yourself a platform to use for your research and at times you do not know where to start... It is one of the biggest challenges because all of a sudden you are given a huge task of coming up with a research topic by yourself. This type of stepping up come with lots of demanding workload that one might not be used to and it put one to a test and it teaches you ways of handling pressure. As the challenges get bigger a person can experience a lot of stress, and you also learn ways of dealing with that... This method of learning might not Seem easy because it just been introduced at BTech level and where the level of expectations is very high ....You get to learn more than what you thought you could learn, and some of the things you learn are outside the scope of the curriculum.'

THINKING DEVELOPMENT

'I personally think and believe that conducting research develops your thinking skills. Since you are to answer questions that rose about a particular matter, the information you find triggers you to think more so that you can answer whatever question is there. You also learn to back-up your thinking because you do not just answer the main question but the sub-questions as well, such as, and then, so what and what if.'

LEARNING APPROACH

'Learning through research has an unstructured approach to learning, cause it allows you to set the scope of the subject, where you have to teach yourself on how to solve the problems, proving facts and come

up with the relevant solutions and recommendations, thus encourages critical thinking on how to approach the problem by becoming more involved in the subject. It develops the ability on how to tie the theory and practice together.'

WORKPLACE PREPARATION

'It is certainly more challenging in terms of self-motivation and self-discipline. Academically it is also a notch above what I have become accustomed to in previous years of study. The dissertation has certainly prepared me for a working environment. I have to do weekly reports in a formal meeting on the progress that I have made in my research during the previous week. I have to work in a team and communicate continuously with members of the team. I have to compose monthly written reports to my mentor on the progress made. I believe that all of these factors have developed the skills generally required by any type of business or enterprise.'

INTERPRETING THE STUDENTS' RESPONSES

The students clearly experience learning at a different level compared to what has been the case during their first three years. It is also very clear that the research project is challenging and even stressful. It is a positive sign that students become critical to the way that they have been taught once they start reflecting about their learning process. The use of the Project Management 'safety net' is thus of paramount importance.

DISCUSSION

A measure of success has already been achieved in providing the support and structure required to assist the students through the role reversal process.

While the focus has been on how the project management approach can assist with overcoming research-learning obstacles, it is important to note that the reverse is also true. What the solution entails is providing a practical application of project management techniques, a principle which is particularly relevant for the practising engineering professional. The research project provides a non-trivial application of project management, and includes the challenging elements of time management, within the context of significant uncertainties and imponderables. The research project does not constitute simulation as from the students' own experience, it is a real problem for which they exercise ownership.

Turning to more fundamental didactical issues, what has been realised is a successful transition from the pedagogical to the andragogical to life-long learning. Compelling students to break away from the typical undergraduate regime, seizing the initiative, and taking responsibility for their own learning, is typical of the pedagogical / andragogical divide. The ownership mentioned in the previous paragraph, is also characteristic of the andragogical milieu. Lastly, providing students with the requisite knowledge skills to complete a significant research project, serves as a particularly good preparation for lifelong learning, and for the survival of individuals in the knowledge society.

It needs to made clear that it is believed that this is indeed a research project and not like the typical final year projects as described by Chua (2001), because the ***nature*** of the activities that the student is expected to engage in, in this exercise, is similar to that required of doctoral and master's level research students. At 4th year level the research process is introduced, and the successful candidates should have demonstrated that they are familiar with the process, and able to perform at an entry level. At master's level a successful candidate would need to demonstrate mastery of the process, and at doctoral level, candidates need to demonstrate their ability to prosecute the process independently, and make a significant contribution to the relevant body of knowledge.

The steps of the research process as outlined above are:

- Identify and define a particular problem, and propose objectives which lead to its solution;
- Identify and engage with the relevant literature;
- Analyse the problem with respect to the literature;
- Investigate alternatives and synthesise a solution;
- Evaluate the proposed solution, and
- Document the process and outputs thereof appropriately in a treatise.

Part of any educational offering is an adequate preparation for the next level. The BTech level research process should contain elements which prepare the student for masters' level studies. From experience Slatter (2005) this is indeed the case, for a realistic preparation for masters' studies does occur – as gauged from the Cape Peninsula University of Technology Flow Process Research Centre (FPRC) experience. At the FPRC an interdisciplinary approach is adopted, which entails students from all the engineering disciplines participating. Students who complete the BTech integrated research project in Civil Engineering are adequately prepared for entry into masters' level studies.

While the methodology reported on is effective, implementing it requires time, dedication and passion – good traditional teaching values and the e-tools for which there are no substitutes. However, it is not attractive to those that operate in the idealised and optimised environment where the lecture method is still preferred. Pearce (2005) provides clear evidence – a different mode of learning is experienced, and higher order learning occurs.

Future research efforts will revolve around measuring and understanding what real learning has in fact occurred, and how to incorporate and evaluate a reflective dimension in this approach.

CONCLUSIONS

As far as can be ascertained, it is the first time that project management has been formally integrated to manage a final year research project. The skills taught in project management are not taught in isolation, but are integrated and applied in managing the entire research project. At the end of the year the students can actually see how project management has, in a very practical way, assisted them in reaching their goals. The integration of project management with adequate learner support is essential – project management alone will not solve the problem.

The hypothesis that project management techniques can be used effectively to relieve the entrapment problem in the transition from taught to research milieu, has only been applied in the context of a fourth year civil engineering course. It is, however, believed that these concepts can be extended to other disciplines and that broad-based progress is possible.

It has been shown that the final year research project is indeed a valuable preparation for the research expected at masters and doctoral degree level.

The fact that an e-learning platform in the form of WebCT® was used to manage the course electronically, vastly improved communication with students.

An effective method of providing support, structure and monitoring progress in order to address the dilemma of the research role reversal has been offered.
The continued research revolves around understanding learning quality and addressing ways to improve this.

Unless the undergraduate programmes are restructured to ensure that more of the type of learning taking place in the final year research project can occur progressively at earlier stages, students will continue to be unprepared and very uncomfortable with the research learning experience, and adapting to

a new mode of learning will remain stressful and problematic.

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