TEACHING PROJECT MANAGEMENT SKILLS IN ENGINEERING, USING ON-LINE PROJECT MANAGEMENT (St Petersburg, Russia)

Izak Smit[1]

ABSTRACT - *The proof of the learning experience can best be established in the application of knowledge gained. Traditional evaluation by examination not only rates the student's abilities, but also the educator's abilities to transfer practical knowledge by means of theoretical data. The process is obviously influenced by subjectivity and time constraints. A more realistic approach is through project management, which allows students to provide proof of knowledge gained, whilst working at their own pace and within personal constraints. Students provide their own scenarios of environment, responsibility, and personal commitment. By these means the educator becomes a facilitator, rather than a teacher, evaluating the student's management skills of the project whilst ensuring technical competence of subject knowledge. The student sets the pace within the broader spectrum of time constraints determined by the course. Ongoing evaluation of the performance rather than the limiting time constraint of a normal three-hour examination paper is effected. A meaningful evaluation of predicted future performance is achieved. On-line offering, utilising the world wide web opens new opportunities. It requires a paradigm shift with regard to the applied teaching methods.*

THE TRADITIONAL RATIONALIST MODEL

The traditional rationalist model of problem solving consists of the following steps:
1. Define and understand the problem
2. Collect data and information
3. Process the information
4. Formulation of a solution
5. Ensuring that the solution actually solves the problem.

The value of projects in engineering training has always been appreciated. It allows students the opportunity to get involved in all aspects of engineering practice, mostly without the negative implications of costly mistakes. This is because we can introduce known project simulations under the guidance of a mentor.

A student attends a teaching institution for a number of years where the emphasis is on attaining new theoretical knowledge. The transfer of information is handed down by distinguished and experienced educators, who use their skills and previous work experience to teach engineering to new entrants. The basics of the theory still hold, but new techniques are taught as they become available. Most teaching institutions also have the advantage of developing new techniques by research and development. At some stage however, students must transfer from the theoretical technological models into practice, applying theory and at the same time adapting to a harsh production-orientated climate.

LEARNING MODELS

We can learn a lot from the different learning models. Peddler[1] adapted Kolb's experiential learning cycle to include:
1. **Experience**: Observing and reflecting on the consequences of action in a situation.
2. **Understanding**: forming or reforming understanding of a situation as a result of experience.
3. **Planning**: Planning actions to influence the situation based on newly formed or reformed understanding.
4. **Action**: Action in the situation based on the plan leading to a new experience.

York[2] has stated that, when using the project method as a didactical strategy, the process is as least as important as the formally presented end product. This has profound implications for the management and evaluation of a project. Around the world the executive is seen as a project manager. Goal orientated work and project management is seen in the same light. A project can be managed by setting and controlling the outcome of set objectives which is the same as any other goal oriented work.

Koontz[3] places emphasis on **management by objectives** for goal orientated work where objectives can be defined as the important end toward which individual and group goals are directed. In engineering the objectives must be verifiable and logically linked to form a network of objectives. These objectives will then become the basis of control whereby periodic measurements will take place and corrective steps will ensure that the objectives are met.

By forcing the setting and management of objectives we have the following benefits:

Improvement of managerial skills: It forces people to think of the end to be achieved and therefore forces logical thinking.

Clarifications of organisation: Roles must be identified and the responsibilities of all role players must be identified.

Encouragement of personal commitment: Without commitment no plan exists.

Development of effective controls: Because it sparks more effective planning, it also aids in setting up standards against

which we can control, because verifiable objectives becomes standards.

Dinsmore[4], identified the role of project management as the way to go when managing goal orientated situations and gives ten commandments for project management:

1. Organise your project team.
2. Concentrate on the interfacing between all areas.
3. Plan strategically and technically.
4. Remember all Murphy's rules - and plan for that.
5. Identify all the project stakeholders.
6. Be prepared to manage conflict.
7. Expect the unexpected.
8. Listen to intuition.
9. Apply behavioural skills.
10. Follow up and take action.

CONVERGENCE TO DIGITAL TECHNIQUES

According to Tait and Mills[5] the possible strategies to optimise the use of digital multimedia in learning will be to consider the advantages and limitations of digital multimedia for use in educational applications and this can be done by looking at three strategies to optimise the efficacy of learning media:

- The learning strategy known as **problem-based learning** (PBL).
- Recognition of the importance of synchronous interactions between a learner and his or her mentor for optimal learning experiences.
- Bohm's worldview of 'wholeness and implicate order'.

Problem-based learning is founded on the premise that learning involves both knowing and doing. Advocates of PBL regard the ability to use knowledge as equally important as acquiring it according to Bridges and Hallinger[6]. What is valued in the PBL approach is the opportunity for learners to gain practical skills by learning how to solve difficult, novel and ambiguous problems by applying theoretical concepts as analytical tools to prior knowledge in a context relevant to their own present circumstances.

The realisation of the value of interaction and 'wholeness' fits well into the concept of digital on-line learning, whether it be through the Internet or Intranet.

THE EVALUATION OF PROJECT WORK

The need for students, having to fit in as soon as possible into the fast changing engineering environment, means that the educator must place more emphasis on, and evaluate more often, the project management skills of the student, rather than their technical problem solving skills.

Ryan[7] states: 'In the future we will have to place more emphasis on synthesis and evaluation and on abduction and induction.' He feels that it will lead to appropriate engineering practice that is both scientific and critical and that is characterised by:

- Vigilant observation and checking of the reality of the empirical world. This means the continuous and critical review of facts and assumptions.
- Avoidance of contradictions, false and unrealistic facts by stating scientific laws, theories and hypothesis in logic and consistent ways.
- Rigor and flexibility, avoidance of dogmatism and the readiness to cast theories and hypothesis aside in the light of new evidence.
- Scepticism of claims of certainty and absoluteness and theories that cannot be refuted in principle.
- Avoidance of value judgements on deservedness and social-political goals and norms.

According to Morgan and O'Reilly[8], when looking at different definitions of assessment, they find in these definitions a couple of significant common themes:

- Assessment is a human activity, involving interactions aimed at seeking to understand what learners have achieved. Like any social interactions, Rowntree[9] implies, there is nothing definitive or exact about the outcome. Assessment may occur in formal or informal ways, and it may be descriptive rather than judgmental in nature.
- The primary purpose of assessment is to increase students' learning and development, rather than simply to grade or rank students performance without first assessing it, but it is implied that grading is a secondary activity to the primary goal of helping learners to diagnose problems and improve the quality of their subsequent learning.

EVALUATION ACTIVITIES FOR PROJECT MANAGEMENT

Teamwork and collaborative assessment tasks. Until the emergence of the Internet and the World Wide Web, the concept of teamwork and collaborative assessment in open and distance contexts had been restricted to those situations where an on-campus, residential or community-based component was to facilitate. In the past, these methods were more commonly introduced into residential schools where group skills were seen as core to the discipline area. Although traditional distance contexts may have incorporated preparatory or follow-up communications between students using the postal or telephone services, the possibilities for hands-on teamwork were clearly limited to the period of time when students were physically together. In the online environment, the possibilities extend to all sorts

of text-based and multimedia styles of teamwork and collaboration. Team-based activities and projects can now be employed using e-mail and discussion forums. With the provision of clear guidelines for students as to their structure, roles and tasks, the online environment allows for small and large group work in problem solving, debate, collaborative authorship and the design and development of prototypes and models. This can be done either synchronously (i.e. in real time) or through asynchronous messages. Mutual support among students can also be developed as a feature of an online course. By acknowledging of the diversity of student backgrounds and their prior knowledge and experience, it is possible to encourage the development of a community of learners and the sharing of knowledge and resources. Through the development of a 'frequently asked questions' file, a data bank of questions and answers may remove the need for many routine queries.

Online dialogue and debate. With freedom from any synchronous demands of communication, e-mail or conference-style discussion can allow a student the time for deeper reflection, critique and analysis before contributing to online dialogue. At the Cape Technikon seminars, small group discussions, small working groups (problem solving, research projects, etc), team presentations/moderating by learners, peer learning groups (including co-authorship of assignments) and research assistance were the best methods to apply.

Simulations and role plays, are representations of real-life contexts in which scenarios are developed either by individual students or by students in response to others. There has been little or no exploration of this in traditional distance education. Use of telephone and videoconferencing might have gone some way to facilitate real-time events, but the effect of geographic dispersal and the need for videoconferencing systems at both ends of the communication has militated against the extensive adoption of videoconferencing for simulations and role plays in distance education. This is also a costly exercise and only feasible in a one-many or many-many situation.

Problem solving . As with the discussion on simulations above, online problem-based scenarios can be delivered either as multimedia and text-based components prepared in advance, or through the facilitation of problem-solving communication processes. Assessment methods include problem scenarios or simulated events, which unfold during the course with increasing levels of complexity.

Online testing. A new opportunity brought about by online technologies is the capacity for students to undertake examinations at home, rather than in invigilated examination rooms. Online testing cannot on its own address the development of higher order skills that are required of students in tertiary programmes; however, it is particularly useful for quick return of formative feedback.

Critical thinking and making judgements. Reports require information to be represented cohesively, highlighting issues and problems, together with recommended solutions or actions.

Performing procedures and demonstrating techniques and managing and developing oneself with **learning contracts** are also excellent ways of promoting self-management. They are commonly used in many disciplines and usually take the form of self-directed small projects in which learners define and articulate an issue or problem, design and carry out a learning project around it, analyse information and differing points of view, reflect on project outcomes, and evaluate their achievement according to self-determined criteria. It is a 'contract' in the sense that the project proposal is initially negotiated with the teacher, particularly in relation to its scope and rigour. Learning contracts are generally highly appropriate for experienced open and distance learners, who have the maturity and self-motivation required for this level of self-directedness.

Accessing and managing information. The focus is usually upon the process and methods of accessing and managing information, rather than an end product.

Demonstrating knowledge and understanding. This broad ability is often assessed in companion with other activities of a higher order such as critical thinking and problem solving. Demonstrating knowledge is often not viewed as an end in itself, unless it is applied or critically examined. Skills developed within this category include identifying, describing, relating, recalling and reporting.

Communicating. Written and visual communicating is assessed at a distance through submitted written material such as *reports, journals and essays.* Although the emphasis is usually upon content, marks and feedback are usually awarded for logic of argument, linking of ideas, correct use of genre, clarity of expression, presentation and layout.

THE PROCESS

The process is then the crux of the project and it must be a team effort by the lecturer, acting as the facilitator, as well as the student. The student supplies the input and the lecturer evaluates the process skills. This method has been used for the past six years with great success. This year sees the first application of the incorporation of on-line learning, because all the students have a component of distance from the classroom. This is because most students study part-time and in the evenings, with some of them too far away from the institute to effectively engage in classroom tuition. Other than that, the above clearly demonstrates the effectiveness of on-line learning and project management teaching through the use of a hands-on approach.[10] The effectiveness of the project was effectively demonstrated through the implementation at this institution.[11]

The course objectives must be set by the lecturer. The lecturer controls the learning process and must set broad goals. The ownership of a project belong to the student and the lecturer becomes the facilitator.

Clarify all organisational roles. Work out the structure of all the role players and make people responsible according to the roles they play. Students can identify the responsibilities and divide that between a larger group.

Student setting personal objectives. A person usually does more when asked to set their own objectives, than when asked to merely do their best. These objectives then also become the basis of evaluation of the project and becomes the most important component of evaluation as it is of a personal nature.

Recycling. By constant reviews of objectives, final objectives can be set to allow for individual styles and different situations.

The projects include the following:

- Project brief and literature search
- Project objectives and planning
- Colloquium and presentation of the project brief
- Evaluation of the project management in terms of quantity, quality, resources and coordination of all the stakeholders and role players.
- Poster presentation conference.
- Peer evaluation during presentation of findings.
- Final product evaluation

As can be seen from this model, the student is evaluated on the process as well as the final product. Subjectivity is partially eliminated by including the process. The presentation of a final product only may lead to the praising of the unworthy role players and will not give an idea on the project management skills of the student.

The project is selected by the student. This allows for ownership of the project to vest with the student. Most of the projects have real-time significance as existing projects from industry. Some of the projects are research topics with either academic or preferably a practical outcome.

All projects must conform to research methodology techniques and a computer based software program is prescribed to determine a uniform process.

Students will determine the application and responsibilities of other role-players or mentors. The lecturer becomes a research supervisor and will for most of the process be the evaluator, more than the person to give full technical support. The lecturer will also be responsible to evaluate and maintain the process of communication.

The Communication takes place in an electronic course management system. This system allows for the tracking of student activities and to keep track of the communication process. Students will find supporting course content on the system and a calendar service will remind the student to meet milestones, or to make known the dates of formal direct communication activities, in this case the seminars, conferences and hand-in dates.

Students can get mail support and also engage in open and closed discussions with the whole group and with individuals on the same groups.

Students can also upload project and presentation material to the group and the lecturer. The medium allows for close control over the system and eliminates the normal excuses of project material getting lost in the mailing system.

Synchronous communication can be used to discuss issues such as the clarification of details through a whiteboard and desk-top conferencing through chat rooms.

DISCUSSION

By choosing a project from their own environment, the uncertainty is minimised and the student starts with a more personal input. The personal nature assists the student with the allocation of resources and the time frame.

The project brief and literature search enables the student to determine the parameters of the project and the environment in which they will work. The lecturer can assist in the scaling of the project. The emphasis is still on the student to find alternative information and information that may influence this project.

The **objectives are set by the student**, incorporating their own resources and time constraints. It forces commitment on the side of the student and in general it is found that the parameters must be scaled down as most students tend to take on more than they can handle. The quality and risk will be set with the help of the lecturer while the cost aspect is determined on the student's own resources. This must be presented on a time-scale plan and will be used to see how well the student can set and reach objectives.

All **role players must be identified** by the student from their own environment as well as the scope of the project and parties directly and indirectly influenced by this project. Human resources utilised by the student depend on the type of project, but the personal input of the student must be recognisable.

Project documentation takes on a different meaning. The different tiers of documentation required, as well as the different presentations allow for the in-depth development of the student's communication skills. Information must be gathered, sorted, utilised, and presented.

Different **communication techniques** are called for by the different types of information required. This part of the evaluation has tremendous value as it allows the student to identify with the project and make it their own. It also allows for the improvement of style and attitude as project managers.

The **final documented project** only supports the process and can be technically evaluated. The process was extensively evaluated and the technical aspects of the final document can now be evaluated as well as the presentation of data.

SIMILAR PROJECTS

In a case study conducted at University of Missouri – Rolla[12] it was found that in the case where an on-line graduate engineering management course was offered more than 50% of the class expected that the course would require more or significantly more time. However, upon the completion of the course, only about 16% of the students felt this way. In relation to overall effectiveness, nearly a third of the student expected the course to be less effective while nearly another third expected the course to be more effective. Upon completion, only 11% believed the class was a less effective learning experience while nearly 58% believed the class was a more significantly more effective learning experience. Regarding the effectiveness for aiding course material comprehension and level of satisfaction using specific instructional tools students, the responses suggest that the majority of students believed that the digitised lectures were effective. In addition, from the data collected, the students preferred E-mail over the ChatRoom environment.

CONCLUSION

Preliminary results indicate that the same result of the above case study will be effected. The department of civil engineering have a pass rate of 75-78% per year. Of this the drop-out rate is normally small and between 4-8%. In the case of project management this was different. The pass rate was always 100% except for 1999 (99%) and 2000(98%). The drop-out was high, between 20% and 30%. This was as a direct result of the practical nature of evaluation and the fact that the process of evaluation allowed for the following distribution: 40% towards the final mark was based on the process and 60% on the technical content of the final project. The biggest reason for the difference between the drop-out and the pass rate of this subject versus the ordinary classroom taught subjects can be found in the fact that students become responsible for their own learning. The classroom contact student find themselves in the situation where they are mere passengers to the system until the final examination where a percentage of the manages to pass an examination based on short term memory, more than on providing evidence of required knowledge.

The early indications are that by introducing an on-line component to the subject, the drop-out rate will improve and the overall pass rate will improve. This is because of the nature of on-line contact, where the course management system allows for continuous reminders and contact. We are only three months into the new application, yet there is a strong indication of the success of the project and that can be seen be in direct correlation to the more formal recording of the communication that takes place.

REFERENCES

[1] Peddler W, Burgoyn J, Boydell T, *"A Manager's guide to Self Development"*, McGraw Hill, 1986

[2] Yorke, D, M, *"Patterns of Teaching – a Source Book for Teachers in Further Education"*, Council for Educational Technology, London 1981

[3] Koontz, Weihrich, *"Essentials of Management"*, McGraw Hill, tenth edition, 1990

[4] Dinsmore, P, C, *"Ideas, Guidelines and Techniques for applying Project Management Solutions in the General Business Arena: lessons for executives"* - Project Management journal, Vol 8 No1, 1990

[5] Tait, A, Mills, R, *"The Convergence of Distance and Conventional Education, Patterns of flexibility for the Individual learner"*, Routledge, 1999

[6] Bridges, E, M, Hallinger, P *Implementing Problem Based Learning in Leadership Development*, University of Oregon Press, ERIC Clearinghouse on Educational Management, 1995

[7] Ryan, T, *"Learning and the Method of Science in Engineering Education"*, National Seminar on Engineering Education in SA, University of Cape Town, 1997

[9] Rowntree, D, "Exploring Open and distance Learning", The Open University, Kogan Page, 1999

[8] Morgan, C, O'Reilly, M, *"Assessing Open and Distance Learners"*, The Open University, Kogan Page, 1999

[10] Slatter,P,T, Smit, I, Bosman J, *"The Importance of the B.Tech Project*, First CTP/IPET/SASCE conference: Technikon Education in Engineering and Related Disciplines - Future Challenges, Eskom Conference Centre, Midrand, 1995

[11] Smit, I, *"Teaching Project Management using project management – a True Hands-on experience*, Annual ASEE conference, Seattle, 1998.

[12] Evans MR, Daily M, Murray SL University of Missouri – Rolla, *"The Effectiveness of An On-Line Graduate Engineering Management Course: A Preliminary Study"*, Annual ASEE conference, 1997

[1] Izak Smit, Centre for e-Learning, Cape Technikon, Cape Town, South Africa, smiti@ctech.ac.za