PBLE: Competition Entry

(Complete according to the accompanying guidelines before this document)

Name(s) of entrant(s)__Norrie S. Edward

Institution The Robert Gordon University

Faculty / School Design and Technology

School Engineering

Degree Programme(s) Mechanical and Mechanical and Offshore Engineering

Award(s) BEng/Meng (Hons) Year(s) of study First

Title(s) of Module(s) Properties of Materials

Project Title Domestic heating and insulation design

Module Credits 15 of year total _120 % project assessment 50

Project deliverables _____

Industrial/ Professional Involvement **YES/ NO** _Students were encouraged to make contacts but no formal links

Group Project: **YES** Group Size__6___ Group Selection: **agreed** between **TUTORS AND STUDENTS**

Synopsis of Project (max 100 words)

The aim was to apply thermodynamic principles and materials properties to the design of heating/insulating or air-conditioning systems for a stone-built or modern domestic dwelling. Student groups applied theory, sourced data, investigated standards and selected materials and systems in a defended solution to the problem. Students gained an awareness of the need to justify decisions by providing technically defensible evidence. They also learned that the solution required compromise and that judgement as well as analysis was needed. A feature of the projects was that groups were paired with each acting as consultant for one project and customer for the other.

Intended learning outcomes of the project

1. Ability to apply heat transfer principles to a specific application
2. Ability to select materials to optimise insulation but taking account of other constraining factors
3. Understanding of design methodology for a thermodynamic system for a given application
4. Ability to apply effective problem-solving strategies to an engineering design requirement
5. The development of group working skills
6. Presentation of technical information effectively in written and oral form
7. Demonstration of the ability critically to appraise technical information

Student Selection
The group formation was suggested by the academic staff but where students expressed a wish to work together this was accepted provided (i) overall group sizes were not affected (ii) none of the other students affected objected to the change. The four projects, two pairs of two, were very similar and were allocated arbitrarily to the groups. The allocation thus determined which groups would be paired and become customer/consultant for each other's projects.

Project Implementation (in 100 words!!)
The groups agreed the dimensions and construction of their house. Building materials had to conform with the house type. Based on this they assessed heat losses and heating requirements taking account of the ambient conditions in all seasons, occupants and appliances. They selected insulating methods based on the technical and economic advantages of options. Energy supply options were analysed and a system selected. Emphasis was placed on the students' sourcing (textbooks, internet, industry etc.) and applying both relevant theory and technical and economic data. Assumptions had to be stated and selections justified. Technical rigour was demanded.

Project assessment
Describe how this project is assessed. If appropriate, include details of moderation and/or marks allocation.

The oral presentation attracted a group mark assessed by two members of staff for clarity, effective use of visual aids but mainly for the robustness of the technical case.
At the same presentation each group's effectiveness in questioning their pair group was assessed for ability to challenge weaknesses in other's case.
Individual reports were required which were marked separately by both members of staff and moderated (upwards) after the second marking.
Peer moderation was avoided with these first year students but students could lodge complaints against non-performers. (None did)

Supporting Students
Describe the facilities made available to the students undertaking this project.
Describe how your institution's staff supports the students undertaking the project.

This was a design project and so the facilities needed were mainly information resources. Possible sources of both technical data and theory were discussed. A session was organised with the library on making effective use of on-line databases. This was a hands-on session and students had been asked to prepare for the session by identifying information they desired which would be relevant to their project.

The basic theory and properties of materials were taught, with tutorial follow up, in class but specifics had to be sourced and evaluated. Students were encouraged to use as many sources of data as possible. This included the Internet, library, (including standards) and d-i-y stores. (There use of different sources was evaluated by questionnaire and although the Internet was the most use it was clear that a wide variety of sources had been accessed). This was intended not only to introduce them to the way in which a professional engineer would approach a design problem but to encourage a critical approach to the evaluation of different sources of information.

Tutor support was provided with 2 staff for the four groups for 2 hours per week. Students frequently took advantage of our "open door" philosophy to discuss their progress and concerns. Staff acted as facilitators i.e. they encouraged effective use and questioned both the process and solution to the design. They did not offer solutions or judgements. We found that the most important function with these first year students was to maintain their confidence in their own abilities to solve the problem and to resolve ambiguities.

External Involvement

Their were no formal links with any outside organisations. Students were encouraged to use sources like d-i-y stores, heating and ventilating engineers etc to obtain relevant data. It is not known how many did so but it is known that some did.

Project Design and Development

This was the first year in which this approach had been used. Previously the Module had been assessed mainly by examination. The low performance in these examinations had been a cause of concern. The entire approach was altered. The emphasis was changed from analysis to an emphasis on concepts. Assessment was altered to be 100% coursework. A deliberate attempt was made to provide familiar contexts to illustrate the concepts which were been discussed. It was a natural adjunct of this to use project-based activities as the means of assessment.

Project effectiveness

Thermodynamics tends to be an abstract subject. Students have difficulties with visualising phenomena and relating concepts to their contextual experience. This project gave them a familiar context and asked them to apply the theory they had learned. It also taught them that engineering design requires the sourcing of data and the evaluation of mathematical models. We emphasised that all engineering design involves a degree of approximation. Students gained an awareness of the need to select a model which gave an appropriate level of approximation and the need to state the assumptions on which their solutions were predicated. These are fundamentals which are rarely addressed in a conventional approach to thermodynamics teaching.

This was a design only project and so there were no financial or materials resource implications. It has to be accepted, however, that the approach is staff intensive. We believe this to be a price worth paying. We were seeking, and believe we achieved, not only the cognitive outcomes nor yet just the development of problem-solving skills but affective changes. Much is said about encouraging independent learning but little is often done to promote this. By encouraging planning, analysis, selection and critical appraisal in a supported environment we believe we have achieved progress towards independence in these learners. This, we believe, will allow their future project activities to be conducted with less intensive support.

Student feedback

Student perceptions were obtained through questionnaire and interview. The majority of the students enjoyed the experience and believed they had learned more theory gained a better understanding of the application of theory and gained better problem solving skills than they would have done from a conventional approach. A cautionary note, however, to those enthusiasts for PBL who believe that all students “love these activities” is sounded by the finding that around a quarter of the students would have preferred a conventional approach. This has been a consistent finding of several such evaluations. Again as has been found before these students chose to remain anonymous and so there objections can only be the subject of speculation. The pass-rate for the Module and for this coursework was 100% with the average grade achieved in the project being 4 (3 = bare pass, 6 = maximum). Less encouraging, however, were the results of a multiple choice diagnostic test of thermodynamics principles which around 60% of the students voluntarily completed. The average score was slightly below the 40% which would normally be consider to be a pass.

We asked the students to complete a learning styles inventory (Felder and Soloman). They proved to be mainly activist, sensory, visual and near the middle of the sequential/global scale. These averages, of course, conceal wide individual differences. It had been hoped that perceptions of the experience would be related to learning style. Perhaps because most of those who had not enjoyed the approach had opted to be anonymous, no correlations were detected. The students themselves were aware that the project-based approach did not suit all. Several of those who had favourable impressions made comments to this effect at interview.

We were aware from previous use of projects with first year students that they would need close supervision and support. This was confirmed by our findings. Although we did not uncover evidence to support it, our belief is that students with a low tolerance for ambiguity and those tending to be reflectors and intuitors are more likely to find these activities stressful. We do not anticipate making any major changes to the approach next session but we will introduce the activity earlier in the semester, provide more detailed documentation and provide milestone checks for the weekly surgeries. There are also plans to set up a Virtual Campus group to promote discussion and peer evaluation of ideas.

Innovation

The main features which we consider to be noteworthy are:

- The subject was thermodynamics and materials i.e. not a conventional design project
- It was first year (first semester) class. Some consider that such classes lack the skills and knowledge to conduct projects. We demonstrated that, given selection of context and level and sufficient support, such projects can be successful
- Each group was both consultant and customer. This encouraged both rigorous justification of their own design and critical appraisal of their partner group's efforts.
- Search methods skills tuition was included in the schedule.