Application of Project Based Study in the Learning Process: A Case Study

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Abstract—The study is a step toward studying the advanced technology specially to learn the control system of CNC lathe machine. This paper describes the development of a closed loop control system with encoder mounting as real-time control device for a conventional lathe. A personal computer is used for calculation as well as for controlling the motion of the drives. The servomotors are used for controlling the movement of carriage. A program is developed using Turbo C for evaluating the overall system. The developed control system is applied to evaluate work piece dimension in real time with the integration of production process. Encoders are used to collect real-time machining data. It is found that the errors are less than 0.005 mm of turning example part on X and Z axes. The average error is approximately 0.002 mm.

Index Terms—CNC, Lathe, real-time control system.

I. INTRODUCTION

EARNING document methods and supporting informational materials in the higher education can be improved for varying disciplines by engaging students to unravel real life problems through project based investigation. The aim of engineering education is to develop skilled manpower to solve real life engineering problems and to meet society’s needs with advances in knowledge. Gray [1] investigated the integration of case study based investigation in engineering courses to establish a practice where undergraduate engineering students exercise their growing technical knowledge and analytical capability in the context of real engineering problem. The applied principals of technical investigations were generic in nature. Harris [2] demonstrated the implementation of the project based design methodologies in an undergraduate course by integrating the relevant theories with hands on design projects. It not only benefits the students but also changes the instructors to integrate theory into practice. Holt [3] reported that students often receive little practice in closing the gap between engineering necessity and technical knowledge. This lacking may lead to mistakes by the students in treating the engineering problems in practice.

Jennings [4] reported on a case where students were asked to expand on the professional dimensions of the implications of the problems they solved as a part of class room teaching and the outcomes of the solutions to engineering problems.

Navaz et al. [5] introduced a new approach in teaching Thermal/Fluid Sciences to undergraduate students through inclusion of new and advanced technologies into the curriculum using latest computational and experimental methods. Musto [6] described the outcomes of the introduction of a project based approach in a numerical methods course where the subject concepts were related to a term-long design project. Student teams were required to report on the design methodology and the results through formal design reports and a presentation. The integrated project based approach assisted the students to enhance their enthusiasm and understanding of the course materials [6].

Mustoe and Croft [7] reported the increased emphasis on open ended design exercises and case studies in engineering curricula. Gomes [8] adopted case studies in modern engineering teachings to improve integration of cross disciplinary education and to develop a professional outlook in the young engineers. Feisel and Rosa [9] identified the lack of coherent learning objectives in engineering laboratory exercises and demonstrated the impact of this shortcoming in limiting the effectiveness of these exercises. Feisel and Rosa [9] encouraged engineering students to seek knowledge beyond the classroom theories. DeBartolo and Robinson [10] demonstrated the successful implementation of design and experimentation in engineering curriculum to develop the students’ concepts on design, build and prove the functionality of the designed project.

The integration of project based investigation into the fluid mechanics course described in this paper has not only provided the students an insight into the fundamentals of fluid mechanics, but also developed students’ abilities to carry out professional tasks in real life. The study has also reported that the suitability of project based study along with conventional lecture classes in fluid mechanics course.

II. SUMMARY OF THE COURSE

In the Department of Sustainability and Infrastructure at CQUniversity, teaching of fluid mechanics course is offered through dedicated course work, laboratory experiments and group design experiments. The core components of the course consists of a collection of weekly modules and contains the general characteristics of fluids, manometry, fluid statics,
analysis of incompressible flow in pipes, analysis of buoyancy and stability of floating bodies and measurement of fluid flow. It introduced the methods of analysing fluid systems using the conservation of mass and momentum equations, Navier-Stokes’ equation combined with the concept of a control volume. To solve the problems in fluid mechanics course, students familiarised with the theories of incompressible flows in pipe systems, Euler’s equation, Bernoulli’s equation and the use of similitude and modelling principles and techniques.

Students were required to act professionally in presenting information, communicating, working and learning individually and in peer learning teams to achieve the learning outcome of the fluid mechanics course. Initially the fluid mechanics course was offered to on-campus students. Later, the existing course was adapted for Interactive System-wide Learning (ISL) delivery on other regional campuses. An online lecture delivery was developed for flexible course offerings with a one week on-campus mandatory residential Learning (ISL) delivery on other regional campuses. The restructured course materials can be used both as supporting teaching materials and as reference materials in project work for research and self-study.

III. STUDENTS LEARNING ACTIVITIES

At the beginning of the course, all students were given an overview of the course to make clear the expectations about how the course would operate. Flex students were introduced to online learning practice and were assessed on online learning skills required for this program. Students were encouraged to study and respond to the review questions and solve exercise problems. They were also familiarised with the real fluid systems and flow phenomena through the laboratory exercises. Students were required to study the text and other course materials as a guide to solve the workbook problems, virtual laboratory activities and other assessment items.

Students were able to discuss their difficulties with problems in the discussion list or email the course lecturer. Students were expected to follow a self-directed study schedule which met the required deadline. The weekly schedule of activities for on campus students were Lectures (two hours per week), Tutorials (two hours per week), Laboratory (two hours per week). A residential school was conducted for flexible and other regional campus students after the midterm vacation. Tele-tutorials over Skype and/or local tutorials were arranged for off-campus students.

IV. ADDRESSING OF GRADUATE ATTRIBUTES

In the design and development process of a technical course for the engineering students, there are several objectives need to consider such as the goals, resources, course learning outcome, and last not the least the graduate attributes. The targeted graduate attributes were Science and Engineering knowledge, Effective communications, Technical competency, Problem solving and systems approach, Functionality in a team, Social, cultural, global and environmental awareness, knowledge on sustainable design and development, professionalism and ethics and lifelong learning.

The graduate attributes mapping was prepared to obtain an indication of how the fluid mechanics course contributed to achieve course learning outcomes and graduate attributes and to understand how attributes are developed as students’ progress from one year to next year. This is done by indicating the graduate attributes targeted by each course learning outcome. The indicative marks are placed under the headings of Teaching, Practice and Assessment to illustrate the course emphasis (low/medium/high).

V. ASSESSMENTS

To pass the course students had to attempt all the assignments, laboratory reports and complete all examinations and obtain a grade of at least 50% and a passing grade in the formal exam. Assessments for the course were on the basis of laboratory reports (20% weighting), a fluid mechanics project plan (20% weighting), workbook submission (pass/fail in competency) and formal examination (40% weighting).

A. Laboratory Exercises

There were three components in laboratory exercises – a formal lab report, video lab questions and virtual lab design and experimentation. The first two components were group assessment items and each group were required to submit a report on the assessments. Every group member contributed to the conduct, preparation and write up of the laboratory report. The objective of involving students in video lab questions and virtual lab activities is to develop higher order thinking from the problem statements and thus a deep understanding of the knowledge on the subject matters. Practical videos in most chapters of weekly schedules were uploaded on the course delivery site.

The students were asked to solve the related practical questions demonstrating the steps with related background knowledge for a virtual lab problem. In the design and experimentation component, the students were encouraged to design an experiment in fluid mechanics from any of the topics covered in the weekly modules that the students would like to improve further in future. Students were required to submit a report on the selected experimentation covering the necessity for the investigation, a description of the work, the parameters requiring observation and the safety procedures. Students were also required to complete the entire laboratory exercise including the drawing of graphs and final answers on issues such as calibration of obstruction meter, flow in pipes, stability of a floating body and velocity profile and pressure losses in a smooth pipe.

B. Engineering Fluids Project

The aim of an engineering fluids project is to ensure that the future engineers will comply with the principles of sustainability though improving their research ability and knowledge of fluid mechanics. The projects related to basic principles of fluid mechanics assist the students to enhance their learning experiences and to achieve the graduate attributes through a team based design approach utilising the concept of sustainability to meet the needs of present and