Research Project-based Learning (RPBL) in Higher Education

by

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Outline

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Background

• RPBL is a pedagogy experiment for graduate module – based on well-known problem based learning
• Students were expected to do self-learning based on selected problem (group work)
• Idea – Let students carry out an independent and original research project and learn all aspects of carrying out a research project from start to finish
Background

• Allow students to define physical domain for a selected problem
• Formulate mathematical model
• Make/justify assumptions to simplify model
• Use research tools, e.g. computational or experimental (if necessary)
• Interpret results - Important aspect
• Presentation of results (written and oral)
Methodology

• Module – Mass Transport (ME6203 at National University of Singapore)
• Instructor– Professor Arun S Mujumdar
• Research staff involved – Agus Sasmito, Jundika Kurnia and Sachin Jangam
• No of students – 14 (Each group of 2 students)
• 40% of the final marks (60% for report, 40% oral PPT)
• Course material – Only initial lectures were redesigned by Instructor to ensure students had a head start when they initiated their project
• Classroom lectures - basic concepts and background needed for project was provided
Methodology

Selection of projects

• Topics selected by Instructor and his research scholars few months in advance (necessary background work was done)

• For each topic, two most relevant references were provided

• Most projects required use of appropriate tools such as Fluent, COMSOL, MATLAB
Methodology

List of projects suggested

- Mass transport enhancement in micro-mixer and micro-reactor
- Gas-particle flow simulation in impinging stream channel.
- Improved gas and thermal management in PEM fuel cell.
- Impinging jet drying for non-planar substrate
- Combustion of a Single coal/coal-biomass particle
- Heat and mass transfer during ‘Frying’
Methodology

Guidance

• Each group was assigned a mentor to provide guidance
• Students were allowed to discuss the problems and solutions with their respective mentors and the module instructor
• Students were expected to be as independent and original as possible
Assessment Methodology

Technical report (60%)

• Students were required to submit a technical report which follows the format of a standard journal article (enhance technical writing skills required for research students)

• Numerous criteria were taken into account for evaluation of report (such as organization of report, originality, analysis of data, critical thinking and conclusions)

• Work on some of these topics was extended and published as research articles in peer-reviewed journals (with an extra effort after the completion of module)
Assessment Methodology

Oral presentation

• Each group was required to present their work for 20 minutes followed by 10 minutes Q&A session

• Students had the opportunity to deliver their work in a conference-like setting complete with an external Chairman (Dr. Poh Hee Joo of IHPC, Singapore)

• Numerous criteria were taken into account for evaluation of oral presentation (such as presentation skills, technical content, subject knowledge, response to Q&A)

• In the course of participating in these projects, most students effectively experienced going through the entire process they would need to go through during their PhD research
Selected results

Group 1 - Numerical investigation of the performance of various micro-reactor configurations

Parallel
Wavy
Oblique fin
Serpentine
Coiled with outer inlet/outlet
Coiled with inner inlet/outlet
Coiled with serpentine
Coiled with double serpentine
Selected results

Group 1 - Numerical investigation of the performance of various micro-reactor configurations

Effect on reaction rate - Mass fraction of reactant
Selected results

Group 1 - Numerical investigation of the performance of various micro-reactor configurations

Effect on pressure drop
Selected results

Group 2 - Mass transport enhancement in T-junction micro-reactor

- Different channel configurations used
Selected results

Group 2 - Mass transport enhancement in T-junction micro-reactor

- Velocity contour plots for selected micro-reactor configurations
Selected results

Group 4 - Modeling Conjugate Heat and Mass Transfer between a Laminar Impinging Jet and Planar and Curved Thin Slab of Wet Solids

Concave substrate

Convex substrate

Outer planar

Inner planar

Physical model
Selected results

Group 4 - Modeling Conjugate Heat and Mass Transfer between a Laminar Impinging Jet and Planar and Curved Thin Slab of Wet Solids

Moisture content
Student Feedback

• Student feedback was very encouraging based on the following questions asked to students

  Q1. This exercise provided me opportunity to think independently and critically;
  Q2. This exercise improved my ability to read papers critically and enhanced my analytical ability;
  Q3. This project has motivated me for life-long learning;
  Q4. The experience I got during this project was very helpful for my doctorate/master of engineering research work
Student Feedback

• Summary of feedback

Percentage of students replied
Selected Comments from students

- “Prepare the fresh Ph.D students on the learning journey of their research life.”
- “The module provided me a fruitful learning and research experience. The techniques I learned included the concept of modeling, critical analysis on the modeling results, writing academic papers, and presentation on the research result. All the experiences are very helpful in my Ph.D candidature period.”
- “This experiment was very helpful for any fresh research student to involve themselves in critical thinking and analysis of the results. It also makes learning a fun-filled event.”
- “It could be purely focusing on this simulation work instead of having regular classes and exams.”
- “The content of the module is quite heavy as in a very limited time (several weeks) we need to learn a completely new concept, understand it and implement it in a research subject. It is quite challenge to gain a clear understanding of the subject in the course period.”
- Suggestion – “some topics from students may also be considered if at all it has some relevance to the module.”
Feedback from research staff involved

• I was blessed with the opportunity as a guest lecturer and group mentor in a graduate course “Mass Transport”. I received very positive feedback from students and I got invaluable teaching experience, which I will implement it on my graduate course in the near future. (Agus Sasmito)

• My experience during this pedagogy experiment was very positive. My personal opinion is that students learnt a lot of useful things which is helpful for their research. I really enjoyed mentoring students and I was impressed with students’ innovative ideas. (Sachin Jangam)

• I was lucky to be a part of RPBL. I got a good experience of mentoring students and received a positive response from students. (Jundika Kurnia)
Concluding Remarks

- When students participate in a learning activity like RPBL, they go through all key aspects of what is needed to complete a PhD thesis.
- RPBL did not affect overall course content- only initial lectures were redesigned (Course content and objectives remained unchanged).
- A major effort is necessary on the part of faculty members and mentors involved.
- Such an exercise can be effectively implemented only in small graduate classes.
- Success and quality of the research outcome from our RPBL exercise is evident from the fact that four research papers are published.
Outcome
