Using the Optimising Problem-Solving Pentagon as a Basis for Research Skills in Final Year Engineering

Karu Purush[1], Tran Minh Hien[1] and Belinda Sta Maria[1]

[1]Research and Learning Department, Library and Learning Commons (LLC), Monash University Malaysia

Corresponding author email address: purusothaman@monash.edu

A peer reviewed short paper for a presentation at the International conference on Models of Engaged Learning and Teaching (I-MELT), 11-13 December 2017. Available from www.imelt.edu.au

Abstract

This paper describes a collaboration between the library and the Engineering Faculty at Monash University Malaysia, using one of the Models of Engaged Learning and Teaching (MELT) known as the Optimising Problem Solving (OPS) pentagon. The setting where the OPS has been applied is in a Final Year Engineering Project (FYEP) where students are required to complete a research project relevant to the discipline. To complete the research project successfully, students need to acquire research skills. This paper focuses on describing a targeted library program for students undertaking this unit, which contributes essential research and academic skills to enable students to complete their project paper. The program covers thesis formatting using Microsoft Word, management of references and citations using EndNote, literature review writing, writing and structuring the report and giving an oral presentation of the report. All the component skills contributed by the library can be mapped to the six Facets of Research described in the OPS pentagon – a distilled version of the Research Skill Development (RSD) framework. The research skill facets within the OPS pentagon may vary in positioning, which provides fluidity when applied to the context of different research projects. Using the OPS pentagon with students can help with explaining research skills in a way that is more digestible than the grid format of the RSD framework. This paper recommends the use of the OPS pentagon for unpacking the problem solving aspect of research projects undertaken during the final year of engineering studies.

Keywords: **F**inal Year Engineering Project (FYEP), I-MELT, Optimising Problem Solving (OPS) pentagon, thesis formatting, research skills, literature review, EndNote, RSD facets, student autonomy

Introduction

The Final Year Engineering Project (FYEP) is an individual research project in which students undertake a particular project and complete it towards the end of their degree program. Though the project may be largely focused on an area of study or discipline undertaken in the first three years, a good part of the research project centres around students developing specific skills that are essential for overall completion of the research project. The OPS pentagon (Mechanical Engineering Tutors, 2014) can be used to embed research skills to facilitate the completion of student research projects and it provides an excellent starting point for students as researchers to navigate the research process and to locate the facets where they are most appropriate. Research skill development support programs are delivered by the library in all engineering disciplines for the FYEP in collaboration with the departments within the School. The collaboration also promotes library-faculty teaching partnerships and is centred on shared development of students' research skills (Torres & Jansen, 2016). Three essential skill development programs are provided for FYEP students in the areas of thesis formatting using Microsoft Word, managing references using EndNote and writing and presentation skills.

This paper proposes the use of the OPS pentagon as a basis for research skills to enable progression of research work. The students will be able to use the OPS pentagon to move the facets to different positions according to the type of skill sets required for the research paper. Moving the most important facet to the centre in the pentagon depends on the different tasks leading to the research. As an example, what appears to be the central facet for thesis formatting may not be the central facet for EndNote citing and referencing. The flexibility of moving the most important facet to the centre for each of the essential skills allows for easy contextualisation and visualisation. This means that the student is able to decide on the central facet for each task and to return to the centre when in doubt (Mechanical Engineering Tutors, 2014). The ease of being able to move the main facet to the centre when required allows the student to see the OPS pentagon as a student researcher-friendly RSD framework. The OPS pentagon is convenient as it allows the skills related to report writing, thesis formatting, managing references and making oral presentations to be determined by the student based on the requirements of the research project. The facets described in the OPS pentagon help to structure the FYEP classes according to the knowledge that needs to be learned (Willison & O'Regan, 2007). Although most students may have developed research skills in their earlier years of study, it is recommended that they use the RSD framework as a guide to research activity.

Thesis Formatting Using Microsoft Word with The OPS Pentagon as a Basis for Research

"Thesis formatting using Microsoft Word" is one of the first research skills sessions in FYEP and it fulfils part of the learning outcomes of report writing in the final year project. For this component skill, the "Communicate & Apply" facet could be placed as a central facet of research, with the researchers being free to move other facets to the centre if they felt was more appropriate to their research plan.

Embark & Clarify

In the case of thesis formatting, the facilitator presents and communicates knowledge that is appropriate to the task of thesis formatting using Microsoft Word. Methods of application include both showing the process for each Microsoft Word function and allowing students to determine which functions they want to apply in the formatting and presentation of their project paper. Students should already know the prerequisite PC skills which are applied to decide which advanced Word functions they want to utilise. The learning outcomes are achieved by students in the process of knowing how to automate, create and format a final project paper using advanced Word functions.

Find & Generate

This facet covers searching for the resources needed for the session. Students first explore Microsoft Word tab by tab to determine which advanced Word functions can be used by students to format their project paper. Based on the "tabbed" search, the student uses the steps discussed for each function and learns how to apply these intermediate and advanced functions to format their project paper. A Google search is also carried out to look at forums from the web to enable the researcher to ask relevant questions and seek answers for the research project. The thesis formatting session provides step-by-step assistance from reliable guides sourced from university websites and reputable publications on Microsoft Word functions. In this facet, students may be able to find resources on advanced and prerequisite Microsoft Word formatting functions.

Evaluate & Reflect

This facet uses resources that are generally considered trustworthy in the academic community as the main information bank for thesis formatting teaching sessions. Reliable platforms provide a forum where people can ask questions and find solutions to their questions on various Word applications and functionalities. Questions

will be answered by experts who are experienced and knowledgeable in the use of Microsoft Word functions. Students will need to evaluate the advice given to them by authorities on the subject.

Organise & Manage

Students preparing their project paper will also need to decide on necessary measures or precautions that users should apply to their writing when they use some of the intermediate and advanced functions. Students also need to determine which prerequisite functions are needed for completing more advanced tasks.

Analyse & Synthesise

Students use this facet to include the methods of the various functions of the software and to grade the functions as “basic”, “intermediate” or “advanced”. Ideas and information need to be combined into a cohesive structure and also to note which Word functions are prerequisites for other more advanced functions. Each Word function will have its own specific methods, prerequisite functions, cautionary measures and purposes. Students will use formatting skills to develop a well-organised project paper.

Communicate & Apply

This facet is the central facet on the OPS pentagon, where students will produce a well-formatted project paper as a result of their research. They will apply functions in Microsoft Word to format and complete their project paper and to submit to the course coordinator.

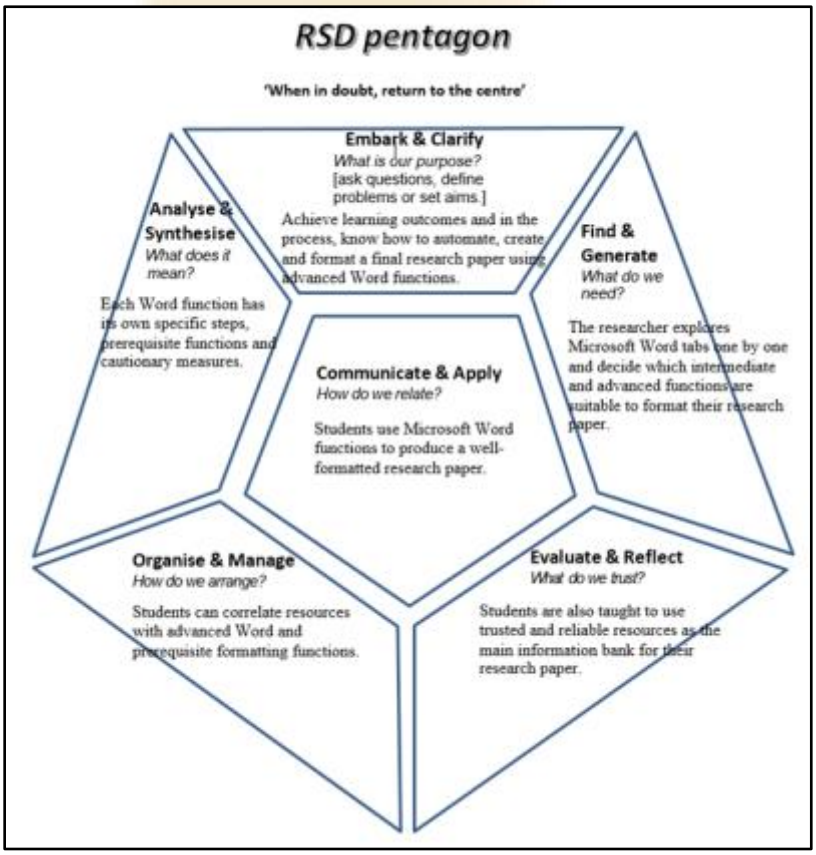

Figure 1: OPS Pentagon for thesis formatting using Microsoft Word.

Using EndNote for managing references and citations, with reference to the OPS pentagon

Managing references and citations with EndNote referencing software training is part of a unit-integrated training program in the FYEP and contributes to students' learning outcomes (Monash University, 2017). The training is aimed at developing students' research skills so that they can cope with the expectation of producing a project paper. The EndNote component of the unit develops students' skills in managing references and citations as part of a literature search. The skills and processes involved in using EndNote are aligned with the OPS pentagon. See Figure 2.

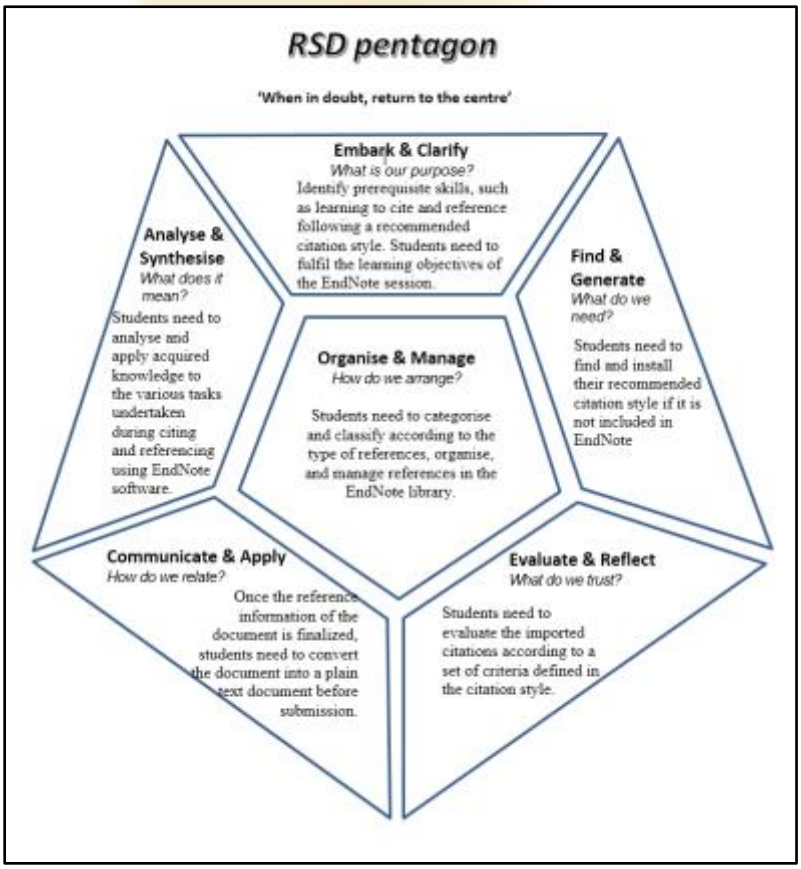

Figure 2: RSD Pentagon for managing references using EndNote.

The diagram above illustrates how the OPS pentagon has been used to describe the skills and processes aligned with managing citations for a literature review using EndNote. In the sections that follow, the skills associated with research will be described as they relate to the OPS pentagon and the process of using EndNote referencing software.

Embark & Clarify

The skills associated with 'Embark & Clarify' are a critical step in the use of EndNote as students are required to familiarise themselves with citation styles and requirements outlined in the unit guide before they learn how to use EndNote.

Find & Generate

During EndNote training, students conduct searches for resources using proper search strategies, and citations for these resources can be automatically imported to EndNote. This enables students to autonomously determine that citations are correctly applied in the project paper using a recommended citation style. Students can attain a more effective and independent learning experience. Student researchers need to apply a range of proper search strategies, including looking for resources using search engines, EndNote, online resources and publications subscribed to by Monash University Library. Students develop EndNote skills through simulation techniques, PowerPoint presentations, LibGuides, and the Thomson-Reuters EndNote website.

Evaluate & Reflect

During the search activity, students are asked to evaluate their sources and ensure that their resources are scholarly and reliable. To use EndNote software effectively, students sometimes need to check and edit references which are not properly imported into EndNote. Students have to correct misspelled terms in EndNote citation entries.

Organise & Manage

The facet that could be placed in the centre of the pentagon for this FYEP program is “Organise & Manage”. With the use of EndNote to manage citations and references that are exported into a Microsoft Word document, students are equipped with the skill of organising citations in a cohesive structure. Students will create an EndNote library and choose their recommended citation style. Once this task is completed, students can start importing and organising their references in the EndNote Library.

Synthesise & Analyse

Students are expected to use the “Cite While You Write” option in their Microsoft Word research document to insert references from EndNote. They can apply the acquired knowledge to the task and combine ideas and information in their research project paper. Students are also able to use EndNote to analyse references for systematic literature reviews.

Communicate & Apply

The facet "Communicate & Apply" is related to converting the project paper into a plain text document before it is submitted to a supervisor. Students might also share the EndNote library and collaborate with their peers to build the library and subsequently utilise the references for their research paper. If students use EndNote online, they can invite fellow student collaborators to share and use the EndNote library simultaneously.

Learning to use a tool like EndNote will require all of the RSD facets highlighted in the framework, with the "Organise & Manage" facet identified as the central facet and as the main theme of the pentagon. Most importantly, the use of the OPS pentagon can explicitly and coherently bring out the skills that are developed during the EndNote training. This is another way to enable undergraduate students to participate in the full spectrum of undergraduate research.

The OPS pentagon as a basis for writing and oral presentation in FYEP

The writing aspect of the FYEP involves a number of skill sets outlined in the OPS pentagon, and this component brings together all the other skills developed in different library sessions of the FYEP program for successful completion of the paper. Before beginning to write, the students attend classes in structuring the report and writing literature reviews, where they are expected to demonstrate awareness of relevant research which will form an integral part of their own research and writing. Research and learning skills developed in these sessions include identifying the purpose of a literature review (Embark & Clarify), planning, arranging and structuring the report (Organise & Manage), integrating, synthesising and evaluating peer-reviewed journal articles (Evaluate & Reflect), identifying research methodologies (Find & Generate) and integrating theories and evidence to draw conclusions (Analyse & Synthesise). Students are required to deliver a formal presentation of their research project which provides an opportunity for feedback (Communicate & Apply) and to practice communication skills as highlighted in Spronken-Smith et al. (2013). The writing section of the report, including the literature review, technical writing skills and oral presentation, are necessary components in the presentation of new and emerging ideas for research reports that require good communication skills. The writing and oral presentation components fit well into the "Communicate & Apply" facet at the centre of the pentagon, as this appears to the student researcher to be the most important facet in writing the project paper. Overlaps are possible, so the OPS pentagon seems to be more researcher-friendly than the linear format of the RSD framework, as the facets can be moved around according to the structure of the report. The OPS pentagon provides for flexibility and eliminates the idea that the facets are arranged in a fixed format.

Conclusion

The OPS pentagon provides a convenient and systematic approach to research, especially in the FYEP program. Workshops on the use of the OPS pentagon as a basis for thesis formatting using Microsoft Word, managing references using EndNote, writing literature reviews, structuring the report and oral presentations could be of benefit to students as they learn to organise their research skills and map them to the OPS pentagon in the way they feel that it suits their purpose. Students preparing for the final year report may find that the advantage lies in being able to develop each skill set separately and to arrange or rearrange the ideas in the order preferred by the student researcher.

Acknowledgement

The authors would like to thank Ms Lynette Torres, Monash University Library, Clayton Campus for providing useful comments and constructive feedback which helped to improve an earlier version of this paper.

References

Mechanical Engineering Tutors. (2014). The Optimising Problem Solving pentagon. Retrieved from http://www.adelaide.edu.au/rsd/framework/frameworks/ops_rev4.pdf

Monash University. (2017). *CHE4180: Chemical engineering project*. Retrieved from http://www.monash.edu.au/pubs/2016handbooks/units/CHE4180.html

Spronken-Smith, R., Brodeur, J., Kajaks, T., Luck, M., Myatt, P., Verburgh, A., Walkington, H., & Wuetherick, B. (2013). Completing the research cycle: A framework for promoting dissemination of undergraduate research and inquiry. *Teaching and Learning Inquiry, 1*(2), 105-118. doi:10.2979/teachlearninqu.1.2.105

Torres, L., & Jansen, S. (2016). Working from the same page: Collaboratively developing students' research skills across the university. (From the International Desk) (Report). *Council on Undergraduate Research Quarterly, 37*(1), 26-33. doi:10.18833/curq/37/1/9

Willison, J. (2009). Multiple contexts, multiple outcomes, one conceptual framework for Research Skill Development in the undergraduate curriculum. *Council on Undergraduate Research Quarterly, 29*(3), 10-14. Retrieved from https://www.adelaide.edu.au/rsd/evidence/related-articles/willison_2009_CURQ_29_3_.pdf

Willison, J., Al Sarawi, S., Bottema, C., Hazel, S., Henderson, U., Karanicolas, S., . . . Naidoo, K. (2014). *Outcomes and uptake of explicit research skill development across degree programs*. Retrieved from https://www.adelaide.edu.au/rsd/docs/pdf/RSD_degree_program_2014.pdf

Willison, J., & O'Regan, K. (2007). Commonly known, commonly not known, totally unknown: A framework for students becoming researchers. *Higher Education Research & Development, 26*(4), 393-409. doi:10.1080/07294360701658609