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Benchmarking international Masters students' baseline level of understanding on engineering management practice and research

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ABSTRACT: Many international students struggle to adjust to a learning environment where they are encouraged to undertake predominately self-guided research with some mediated consultation with their supervisor. Traversing this *learning culture* abyss can take some students up to six months before they are ready to tackle the challenges of their projects. In an attempt to understand newly enrolled international Masters students' perceptions of engineering management practice and research, the author reports in this article on five in-depth interviews. These interviews were conducted in the first few weeks of the students' programme commencement, and they were requested to comment on their previous study and industry experience, perceptions of engineering management practice (EMP) and perceptions of engineering management research (EMR). The outcome of this first stage of a larger study was the categorisation of students' baseline level of understanding of engineering management practice and research utilising a SOLO taxonomy.

INTRODUCTION

In recent years, the proportion of international students participating in the Australian higher education sector has increased exponentially. Moreover, this same trend is being experienced in the USA, in Europe and in other developed nations, resulting in an opening awareness of the international dimension in higher education [1]. However, in many cases, international students studying in Australia typically link socially with similar others, hardly interacting with local students [2].

Since the English language has come to play a prominent role in internationalising curriculum and linking the academic profession, it has become essential for international students to have a high level of English proficiency prior to commencing dissertation writing. A number of studies from English-speaking host countries suggested that international students' overall ability in English is closely related to their academic success and overall adaptation [3][4]. This is particularly true for thesis writing, where a student may undertake a high quality research project, but does not receive a commensurable grade because they failed to articulate their literature review and findings in a professionally structured academic writing style.

Although the mastering of academic writing and verbal presentations in English is one of the fundamental difficulties facing many international students, they must also adapt to different teaching and learning styles to successfully complete their thesis project. In particular, research undertaken by Tompson and Tompson cites behavioural characteristics, such as limited classroom participation, not asking for clarification, and studying only with international students, as behaviours that undermine international students' academic performance [5]. Moreover, before international students can become confident self-learners they must make a significant behavioural adjustment by shifting from an instructional method of learning to a free learning environment in which they have to solve problems rather than memorising facts [6]. In particular, students needed to be more independent in their approach instead of relying on thesis supervisors. Through understanding students' perceptions of research at the commencement of their thesis projects, improved learning strategies can be developed and implemented.

The primary objective of this study is to develop a framework that attempts to encapsulate the learning constructivism process for international students over the lifecycle of their engineering management coursework Masters programme. This will be achieved through a longitudinal study where in-depth interviews are conducted with newly enrolled international students at the commencement, middle and end of their engineering management programme. In this article, the author presents the results of the first interview (programme commencement) with five students who commenced the Master of Engineering in Engineering Management programme. These interviews requested that the students provide their perceptions on engineering management practice and research. The outcome of this first stage of a larger study was the categorisation of students' baseline level of understanding of engineering management practice and research utilising a SOLO taxonomy.

RESEARCH METHOD

The research method for this project consists of three sets of interviews with students over the life of their engineering management programme. In total, five newly enrolled international students in the Master of Engineering in Engineering Management programme were requested to participate in this research study. It should be noted here that this article only presents the outcomes of the first stage (interview 1: start of programme) of the research project. The

objective of these interviews was to ascertain the students' perceptions of engineering management practice and research. The five interviewed students were all male and originated from three nations in total (India: 3, Taiwan: 1 and Bahrain: 1). All of the students have completed an undergraduate degree in a discipline area of engineering and had limited experience in industry (two with no experience, while the other three had 0-3 years of experience). Interestingly, none of the students had undertaken a thesis project during their undergraduate studies. In Australia, most undergraduate engineering programmes require that students complete a minor thesis project in their final year of study.

INTERVIEW QUESTIONS

The students were requested to respond to a number of questions (see below) across three areas, namely: perspectives of engineering management practice; perspectives of engineering management research; and perspectives on an engineering management scenario. The objective of these questions was to gauge each student's perceptions of engineering management practice and research, and attempt to classify their *baseline* understanding using an appropriate taxonomy. Further interviews will be undertaken with the same students, using a series of similar questions, to ascertain any growth in knowledge and/or interpretative skills in the engineering management practice and research areas.

Part A: Perspectives on engineering management:

- Why did you undertake the engineering management degree?
- Explain your industrial experience to date?
- What does an engineering manager do in the context of your industry?
- What do you think are the major problems or issues that an engineering manager has to face in the industry?
- What information, knowledge or subject matter would you consider important in studies on engineering management?
- What engineering management skills do you hope you will gain from your study towards the engineering management degree?
- What type of position would you like to take up at the completion of this degree?

Part B: Perspectives on engineering management research:

- What do you think constitutes research in the area of engineering management? Give an example if that helps?
- What do you think is the purpose of engineering management research?
- What are some of the pressing engineering management issues requiring research attention in the industry you work (or were educated) in?
- What would you like to research in the engineering management discipline?
- What knowledge/skills do you have that would help you successfully undertake a research project in engineering management? Give an example if that helps.
- How do you think you might go about your research project? I realise that you have not started the programme yet, but I would be interested in learning your ideas at this stage.
- What do you think that a thesis or dissertation is intended to do?
- What outcomes do you hope to obtain from your research project?
- What do you believe to be the role of a research supervisor in helping you successfully undertake a research project in engineering management? Give an example if that helps.

In Part C: Perspectives on an engineering management scenario, the interviewees were presented with an engineering management scenario where some research outcomes were required. They were requested to answer the following questions related to the scenario.

- What do you think would be the objectives of this research study?
- How would you go about meeting these objectives, ie what steps would you undertake?
- How would you gain the necessary information to achieve your objectives?
- What do you think would be the outcomes of this study and how would this benefit your company?

STUDENT RESPONSES

The above-mentioned questions were asked to each of the five interviewed international students commencing the Master of Engineering in Engineering Management programme. The following sections provide sample responses to some of these questions.

What engineering management skills do you hope to obtain in this degree?

- *Interviewee 1*: Like how to manage the process. What should be the production line?
- *Interviewee 2*: I think how to plan it. Manage the business risk and how to schedule resources. How to define the factory's units per day. Actually that's all.
- *Interviewee 3*: Time management, planning, evaluating the risk, make the plan.
- *Interviewee 4*: Technical skills. Like what are the problems we face while designing something? Maybe how to organise the things from the start and how to look after them.
- *Interviewee 5*: Managing skills. I will not be able to give you an appropriate answer. I guess you need a lot of skills. Managing the entire set-up. Human relations skills are important. Finance skills. Risk. I am just guessing these things.

What do you think research is?

- *Interviewee 1*: I think that research is just like learning. You have to learn more things that you don't know.
- *Interviewee 2*: Research is, I think, going into some field and trying to take profit of that. We don't have a lot of money to do research on waste things; we do research to have some profit on it.
- *Interviewee 3*: Learning. Learning and innovation. Research is something that you can innovate with it; you can bring out new stuff, but at all times you are learning, whichever way you look at it.
- *Interviewee 4*: Learning something new.
- *Interviewee 5*: Learning something. Finding out ways to get a maximum output.

What do you think engineering management research is?

- *Interviewee 1*: I think it maybe about saving time or money. Maybe about gaining info on other countries. Maybe the design of your project or something.
- *Interviewee 2*: I have no idea yet. I have not gone for research methods yet so learning how to get maximum output. You have to study and then apply it.
- *Interviewee 3*: I don't know. I would like to learn how to manage a construction project in an effective way.
- *Interviewee 4*: Product improvement. You have a product and a specification; you want to improve on it. Process innovation also. Understanding a product. Engineering management is a broad field; you can do lots of stuff.
- *Interviewee 5*: I don't know exactly. But maybe how to manage resources. Maybe how to design a completely new industry.

What do you believe to be the role of the research supervisor?

- *Interviewee 1*: On how to start the dissertation. The topic of the dissertation. So, if the start is on the wrong direction after going a long time, oh I would have started that way. The supervisor should guide the right way.
- *Interviewee 2*: Just I think he should give the idea and the dissertation and the direction. Evaluate your job.
- *Interviewee 3*: Whenever one needs some guidance he will be able to tell you what you need to do. The option is yours. You can't go running for every detail but he can guide you to get out of your problem.
- *Interviewee 4*: He should be the right person with the right knowledge. If I have some misconceptions they should be cleared. The research will be done by the person but you need a lot of guidance for it. Like 60/40 percent (ie 60% researcher; 40% supervisor).
- *Interviewee 5*: I think, because I never done research, maybe just help me, maybe, I didn't know something, he can correct me. Help me in many things. I don't know.

From the students' responses, it appears that some students have a better aptitude for research. Generally, most students know what engineering management research could be but are not sure how to proceed at this stage. As expected, the students are biased towards technology/technical research (engineering blinkers on) and lack an understanding of the broader range of issues that an engineering manager must face on a day-to-day basis (eg safety, human resources, etc). From the interviews, it becomes evident that the students have experienced a very different teaching and learning style than their Australian counterparts. Some of the students may initially find it difficult to work in an environment where independent enquiry is a valued learning mechanism.

SOLO TAXONOMY

The Structure of the Observed Learning Outcomes (SOLO) Taxonomy can be used to set learning objectives for where students *should* be, at particular stages of learning or, probably more appropriately, to judge or report on the learning outcomes or the levels attained [7][8].

For the purpose of this research, the taxonomy was used for benchmarking the baseline level of understanding of the five interviewed students. The taxonomy consists of five levels of understanding, as detailed below:

- *Extended Abstract*: student conceptualises at a level extending beyond what has been dealt with in the actual teaching. Can generalise to a new area.
- *Relational*: Indicates orchestration between facts and theory, action and purpose. Understanding of several components that are integrated conceptually. Can apply the concept to familiar problems or work situations.
- *Multi-structural*: Indicates understanding of boundaries but not of systems. Understanding of several components but the understanding of each is discreet. Disorganised collection of ideas or concepts around an issue. Has not been able to relate the items in the list.
- *Uni-structural*: Concrete, minimalist understanding of an area. Focuses on one conceptual issue in a complex case.
- *Pre-structural*: No understanding demonstrated.

BASELINE LEVEL OF UNDERSTANDING

Due to the size constraints of this article, a detailed description of the level of understanding of only one student (Interviewee 4) has been provided. However, a summary of each student's overall level of understanding for EMP, EMR and associated comments is provided in Table 1. The SOLO taxonomy was considered to be the most appropriate framework to map the baseline level of understanding of the students in two areas, specifically: engineering management practice (EMP) and engineering management research (EMR) [7]. Firstly, a summary of the responses for interviewer 1 (I-1) for EMP is detailed below:

- *Role of an engineering manager*: purchase of raw materials, inventory management and markets;
- *Problems faced by an engineering manager*: mechanical failure in production, maintenance, meeting production targets and maximising profits;
- *Important subject matter in EMP*: resource planning, consumer marketing and project management;
- *Engineering skills you hope to gain from programme*: unsure.

This student's perception of engineering management practice was still largely focused on the technical role of an engineer. The student understood that an engineering manager may be involved in some project management and marketing issues, but was unsure of the skills that an engineering manager may require and how these skills could be applied to overcome problems that they may face in such a role. Overall, the student demonstrated a uni-structural level of understanding of EMP but displayed some multi-structural understanding of the *hard* EMP areas (see Table 1). Secondly, the student provided his perception of EMR, which is detailed below:

- *What is EMR*: learning something, optimising and learning how to get maximum output.
- *Purpose of EMR*: make maximum output, quality improvement and invent something new.
- *Pressing issues in EMR*: automation; technical improvement of products, opening up markets and process improvement.
- *EMR approach*: sort out what the specific problem is, why we are getting this problem and how can it be minimised.
- *Outcomes of EMR*: get a maximum thing.
- *Role of supervisor*: they must have the right knowledge; clarify questions and get me onto the right direction, a lot of guidance should be what is required.

Table 1: SOLO taxonomy of EMP and EMR understanding.

No.	EMP	EMR	Comment
I-1	Uni-structural	Uni-structural	Definite perceptions of EMP and what it encompassed. However, the student could not demonstrate an understanding of the interrelationship between EMP sub-groups. The student's perception of EMR was narrowly focused on productivity/cost related topics.
I-2	Multi-structural	Multi-structural	Due to the student's industry experience, the student was able to comment on the various aspects of EMP. Moreover, the student could cite some examples where EMR could be conducted.
I-3	Multi-structural	Uni-structural	This student had a solid grasp of discreet EMP principles, but lacked an understanding of how to undertake EMR on a broader scale.
I-4	Uni-structural	Pre-structural	The student had a basic understanding of EMP. The student demonstrated very little understanding of research in general, and specifically EMR.
I-5	Multi-structural	Uni-structural	The student's industry experience provided the student with a deeper understanding of discreet EMP issues. However, the student's view on EMR was limited and disorganised.

The student had some definite perceptions as to what the student believed EMR involved. The student perceived that EMR was focused on obtaining maximum output from engineering processes (ie process improvement). The student also had some idea as to how to approach his research and how to interact with his supervisor. However, the student had a relatively narrow view of EMR and overly simplified the EMR issues that needed addressing in the industry. In summary, the student has a uni-structural understanding of EMR.

SUMMARY

International students commencing the Master of Engineering in Engineering Management programme at Griffith University typically have limited research and industry experience. In particular, many of the international students completed a highly technical undergraduate degree that did not include any management-focused courses. Additionally, these students fight an uphill battle when delivering oral presentations and trying to master academic writing in English.

In this research, the author has sought to understand how an international student perceives engineering management practice and research at the commencement, middle and completion of their programme with the view to evaluate their learning outcomes over the duration of their programme. In this article, the author discusses some of the students' responses to the first interview, which will be used to establish the students' baseline perception of engineering management practice and research.

These baseline perceptions of engineering management practice and research have been mapped utilising a SOLO taxonomy. Future research will build upon this taxonomy by including further interviews with the same students at the middle and completion of their thesis project. Ultimately, a framework will be developed that attempts to encapsulate the learning constructivism for international students over the lifecycle of their engineering management coursework Masters programme.

FUTURE RESEARCH

Future research will build further on this taxonomy by incorporating further interviews with the same students at the completion of their thesis project, with the view to developing a framework that seeks to encapsulate the learning constructivism for international students over the lifecycle of their engineering management coursework Masters programme. This process will serve to assist engineering academics to develop programmes that better cater to the needs of international students.

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