Managing Transdisciplinary Postgraduate Research in Engineering Education: An Experience in Architectural Acoustics

Md Najib Ibrahim[a,*], Tharek Abd Rahman[b], Mokhtar Harun[b], Ngasri Dimon[b]

[a]*Kulliyyah Architecture & Environmental Design, International Islamic University Malaysia, Jalan Gombak, 53100 Kuala Lumpur, MALAYSIA.*
[b]*Faculty of Electrical Engineering, Universiti Teknologi Malaysia, 81310 UTM Skudai, Johor, MALAYSIA.*

Abstract

This paper is written to share lessons in managing a transdisciplinary research. Due to its transdisciplinary nature, research on architectural acoustics requires collaboration between members of diverse training and experience. The first challenge in the collaboration is to agree on whether or not to accept the problem which does not fit into any traditional disciplines as 'engineering'. The second challenge is to arrive on a consensus on the concepts and method to be adopted. In managing trandisciplinary research, the problem is more of management in nature. Realising the need for this skill for future engineers, Accreditation Board for Engineering and Technology 2000, for example, has included this skill in its learning outcome.

Keywords: Transdisciplinary; Engineering Education; Architectural Acoustics; Postgraduate

1. Introduction

The transdisciplinary research program in architectural acoustic at Universiti Teknologi Malaysia in late 1990s was a collaboration between the Faculty of Electrical Engineering and the Faculty of Built Environment. The program involved Acoustics Laboratory, a laboratory assistant, two doctoral student, and two lecturers of the Faculty of Electrical Engineering and a lecturer of the Faculty of Built Environment. At that time, The Faculty of Electrical Engineering had PhD candidates and good research facilities, but not the expertise to supervise a doctoral research in acoustics. On the other hand, the Faculty of Built Environment had the expertise not only to supervise the PhD research but also to attract research funding but did not have neither the candidates nor the laboratory.

The smart partnership had successfully attracted an IRPA Research Grant and produced two PhDs, one of them is the first PhD in Acoustics produced locally. It is perhaps useful to reflect on what has been learnt from the smart partnership and how the experience can be used to improve other programs in engineering. For the purpose of this the following discussion, team member of this postgraduate research means anybody directly related to the production of PhD graduates including the main supervisor, the supervisor on expertise, other supervisors who provide technical advice, and members of examination board.

The following observations seem particularly relevant to some of the issues that face engineering education today.

2. The nature of architectural acoustics problems

The first challenge was to agree whether or not the research problem – in architectural acoustics – is an engineering problem that the research students could be conferred with a doctorate in electrical engineering. The economic and environmental problems faced by the industry and society are increasingly global, and the problem solving skills required go well beyond the historical scope of engineering practice [1]. Today, the problem is ill defined, likely nonlinear, multidisciplinary, and complex, with many possible solutions [2]. Most of the problems to be solved by professionals today is beyond the scope of a single discipline.

2.1 Multidisciplinary and Interdisciplinary

* *Corresponding author. Email: drnajib@iiu.edu.my*

The research problem beyond a single discipline is known as multidisciplinary and interdisciplinary. The terminology is sometimes used interchangeably. The distinction between the two terminologies is well covered in literature, for example [3]-[4]. It is more complex than monodisciplinary research problem. Monodisciplinary research problem is restricted to one research discipline and to one branch within a research field. Those working within one discipline study the same research objects, share the same paradigm, use common methodologies, and speak the same "language". When a research involves collaboration of more than one discipline, it may be either multidisciplinary or interdisciplinary.

In multidisciplinary research, a number of different disciplines collaborate in one research program without integration of concepts, epistemologies, or methodologies. However the integration occurs during the linking of research results. In interdisciplinary research, the collaboration involves integration of concepts, methodologies, or epistemologies.

2.2 Transdisciplinary

Transdisciplinary is sometime considered as a specific form of interdisciplinary. Here, boundaries between and beyond disciplines are transcended. The integration includes knowledge and perspectives from different scientific disciplines as well as non-scientific sources. Transdisciplinary research emerged from the increasing demand for relevance and applicability of academic research to the challenges of our complex society. It is a new form of learning and problem solving, involving co-operation among different parts of society, in order to meet complex challenges of society. The problem solving skill is developed in collaboration with multiple stakeholders. Through mutual learning, the knowledge of all participating parties is enhanced.

2.3 Acoustics as a Transdisciplinary Research

Acoustics itself involves diversified disciplines from hard to soft sciences. Acoustical Society of America categorises acoustics into thirteen sub-fields - acoustical oceanography, animal bioacoustics, biomedical ultrasound/bioresponse to vibration, engineering acoustics, musical acoustics, noise, physical acoustics, psychological and physiological acoustics, signal processing in acoustics, speech communication, structural acoustics and vibration, underwater acoustics, and architectural acoustics [5].

Research in acoustics, according to Acoustical Society of America, involves expertise in diverse disciplines including nearly all engineering disciplines (such as electrical, mechanical, civil and aeronautical), physics, measurement technologies and instrumentation, robotics and computer sciences, oceanography, underwater propagation, biology, physiology, psychology, speech and hearing, music, noise and noise control, animal bioacoustics, structural acoustics and vibration, and architecture.

A broad diversity in methodologies occurs even within a sub-discipline of acoustics. For example, in architectural acoustics, ambient noise of a room is rated using Noise Criteria Method, but if rumbly and hissy noise exists, Room Criterion Method is used. Another example is the use of different noise reduction rating for different building element: Impact Insulation Class for floor and Sound Transmission Class for wall.

2.4 The Research Problem

The architectural acoustics research at Faculty of Electrical Engineering, Universiti Teknologi Malaysia, is an example of transdisciplinary research. The research to determine coefficient of absorption of direct piercing wood carving is motivated by economic considerations. It saves cost if wood carving in mosques could be utilized beyond its aesthetic function as a sound absorber. In general, designers ignore the sound absorption of wood carving simply due to unavailability of coefficient of absorption data on the wood carving. On the other hand, wood-carving sometimes become part of the mosque's design because it creates local identity. It would be a waste if wood carving in mosque provides only the aesthetic function.

2.5 The Observation

Initially there was a deadlock to enable the postgraduate students be supervised by an outside professor but be conferred with a doctorate in electrical engineering. With wise intervention and strong support from top management a negotiated arrangement was finally reached. First, for the student to be conferred with PhD in Electrical Engineering, the main supervisor should be a senior professor in electrical engineering. Second, the PhD students should benefit from the expertise of the professor in architecture who advises on the overall structure of the research and monitor the day-to-day running of the research. The students also received specific technical advice from another lecturer in the Faculty of Electrical Engineering and a MARDI officer. This negotiated arrangement aim at possibility of 'one-upmanship' situation in the supervision team.

3. Disciplinary Differences as a Stumbling Block

The second challenge is to overcome the differences. One of the lessons learned in this research is concepts, epistemologies, or methodologies as seen by different team members may be significantly different. A lot of time may be spent on debating the 'fundamentals', which may have no single answer, sometimes reaching a level of hostility.

Two examples are given here to illustrate the difference:

First, to decide the most appropriate characteristics of wood carving to be the subject matter of research. It can be either coefficient of transmission or coefficient of absorption. It is a grey area. However, the decision has an extensive implication. As a doctoral research, the research should be an extension of existing knowledge. This would involve an extensive literature review. However, the two did not only require different set of literature but also involve different methodologies. It is likely under such circumstances, a particular team member attempt to stick to the methodology which that person is most familiar.

Second, to agree on 'fundamental' concept of a perfect sound absorber. The first school of thought defines an open window as a perfect absorber. Therefore, 1 square metre of open window is defined as 1 metric Sabin. The other school of thought could not accept that once a sound leaves a window it is 'completely' loss. Both fundamental concepts are well established.

3.1 The Observation

At PhD level 'ignorance' in the fundamental to some academicians, is regarded unpardonable. Therefore, the debate on the fundamental 'flaw' was heated. The other side of the argument needs to be explained to remove the impression of ignorance. Some members of the teams were good in handling the conflict. They repeated the explanation in a positive way and in non-threatening manner.

4. Concluding Remark

Trandiscipinarity is the emerging type of research. The problem in managing trandisciplinary research is more a management issue. Management was not taught in most engineering schools until relatively recently. As a response to this, Accreditation Board for Engineering and Technology 2000 Criterion 3 has listed an ability to function in multidisciplinary teams as a skills to be taught in the engineering program.[6]

The observations discussed above show the importance of knowledge in conflict management. In this case, the team members are very knowledgeable and experienced. Therefore, the real challenge is to coordinate the abilities and experiences of other team members. The observation agrees with the principle of conflict management, for example Quality Quest [7]. Quality Quest suggests three strategies:

1) If the team members are already comfortable working together and the level of experience is appropriate, try to establish a mentor relationship. This strategy is particularly effective if a team member is senior, for example professor. Ask the person to be the mentor to give 'advice'.
2) Remove the one-upmanship ego by letting the other team member feel big too.
3) If the team gets static, hostile, or gives random content instead of the true information required, repeat the remarks in a positive way and try to hook the colleagues' remark in non-threatening manner.

For those trained prior to Accreditation Board for Engineering and Technology 2000 Criterion 3, it is worthwhile to include the management articles that provide practical tips as one of our light readings.

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