

# **IRnAfAtMaGaFEx: A Template File for Integrated Records and Analysis for Attendance, Marks for Continuous Assessments, Marks for Final Exam, and Grading Criteria**

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## **Abstract**

This paper describes a template file (TF) for keeping important records for attendance, marks for continuous assessments, marks for final exam, and grading criteria for a particular academic course in one place in softcopy. The template file was developed using Microsoft Excel and named **IRnAfAtMaGaFEx** (abbreviation for **I**ntegrated **R**ecords and **A**nalysis for **A**ttendance, **M**arks and **G**radings, and **F**inal **E**xam). The TF also provides some analysis which enables the lecturer to make appropriate decisions or take actions based on latest available data and information in the template file.

**Keywords:** template files; integrated records

## **1. Introduction**

Relatively recently Outcome Based Education (OBE) is a new buzzword in Malaysia. All Institutes of Higher Learning (IHL) in Malaysia will eventually need to implement curriculum with emphasis on OBE, where clear program educational objectives and program outcomes are necessary, in order for their graduates to be recognized and accepted in global job market. The focus now is for all engineering programs offered by all IHL in Malaysia, either public IHL or private IHL, to be accredited by Engineering Accreditation Council (EAC) which made it necessary for all engineering programs offered to be outcome based [1].

In simple words, four steps in a continuous loop describe what is necessary in OBE. The first step is we say what we do. The second step is we do what we say. The third step is we prove what we do. The fourth step is we improve what we do. Then repeat the first step. The main purpose of OBE is continuous quality improvement in delivering the best education to the main customer, the students, which in turn provide good and well-rounded workers to the employer (or the job market).

In implementing the third and probably the fourth steps in the continuous quality improvement loop, keeping proper records is very important. The records will become evident of teaching and learning processes, as well as evident of learning outcomes when the time comes for validation or accreditation of the program at the IHL by external evaluators or during accreditation process. This is particularly true for private IHL, like UNITEN, when accreditation process is taking place whenever it is due, and

previous accredited period for the program is nearly over. For engineering programs at UNITEN, evaluators will come and do their assigned duties as specified. Among other things, they will interview the lecturers and asking all sort of questions, and also require records about the course, which also including samples of 5 best, 5 medium and 5 lousy answer scripts of the final exam to be provided. For OBE, the evaluators would be asking for other records like minutes of meeting when curriculum was developed, reports from the external examiner etc. With proper records and achievement of the outcomes at the end of every semester, the course can be evaluated and validated. Actions should be taken to rectify shortcomings, and later the course contents and delivery are continuously improved from time to time, taking into account feedbacks from the assessment and validation processes.

**IRnAfAtMaGaFEx** was developed by the author to contribute in proper record keeping of student attendances to the class, marks for course works (CW) in continuous assessments and marks for final exam (FE). These records are kept in softcopy using a single Microsoft Excel file. The beauty in using a spreadsheet like Microsoft Excel for keeping the records is that user is able to see all raw data entered into the file, compared to using a database where user may need separate coding in order to be able to see the data.

With relevant and necessary data entered by the lecturer regularly, the TF will automatically produce letter grades based on CW and FE marks at the end of the semester. Altogether, the "lighter version" of TF can handle up to 28 assessment categories (such as quiz, test, assignment, term paper, etc and the FE)

for 2 classes of the same course (or subject), with records for up to 70 students per class. A “heavier version” for 4 classes is also available.

## 2. Features of IRnAfAtMaGaFEx

The **IRnAfAtMaGaFEx** was developed using Microsoft Excel<sup>®</sup>. The “lighter version” consist 14 worksheets; where 8 worksheets are used for keeping the records, 2 worksheets are used for setting necessary parameters, and other 2 worksheets produce reports according to prescribed format.

Eight worksheets are used for keeping attendances data, marks for CW (excluding quizzes), marks for quizzes, and scores for the FE for a maximum of 2 classes with a maximum of 70 students in each class of the same course (or subject). For each class, 4 worksheets are used, where 1 worksheet each is used for attendances records, marks for CW, marks for quizzes, and scores for the FE respectively. There are two more worksheets used to set required information (or parameters) about the course, the lecturer, how an assessment is implemented, and setting the full marks and percentage for each assessment activity and the FE questions. Lecturer may also set criteria for grading. Other two more worksheets provide summary for marks and grading, and select 5 best, 5 medium and 5 lousy answer scripts from the final exam. The following sections will describe each worksheet (**WS**) in sufficient details.

As a preventive measure, in order to prevent lecturer from unintentionally entering wrong data at the wrong place, which as a consequence may cause unexpected results, the worksheets are protected from this condition. Lecturer is only allowed to enter data at designated cells in the worksheets. These areas are marked with yellow color. Sufficient instructions are given on the worksheet to provide enough guides for the lecturer to use the TF correctly.

### 2.1. *WS for Students' Particular and Attendance (SPAt) Records*

Important data about students, especially their names and identification numbers are entered into the WS for SPAt Records at least once. This vital data will be copied to other worksheets, i.e. WS for Marks and Grading Records (refer to section 2.2), WS for Students Mark and Grade, WS for Quiz Marks Records (refer to section 2.3), WS for Final Exam Marks Records (refer to section 2.4), and WS for Final Exam's 5 Best, Medium and Lousy Marks.

Other important data for the WS for SPAt Records is the class plan, consisting type of class

activities (such as lecture, tutorial, test, quiz, visit etc) and the date that each class activity is conducted, also required to be entered into the WS for SPAt Records at least once.

Another important data for this WS is the attendance records. With data for the attendance entered by the lecturer regularly, perhaps on weekly basis, the WS for SPAt Records can show pattern of attendances by students to the class, for the whole class and individually, attendance statistics for each class session, percentage of attended and missed class for every student, missed class with medical reason and other allowed excuses for not attending the class, as shown in Fig. 1. The lecturer can enter the data by simply copying and pasting certain symbols available on this WS. Different colors are used to differentiate different symbols. When the WS for SPAt Records are filled with these symbols, the lecturer can easily observe the pattern. Combining the pattern with the statistics of percentages for attend and absent by every student, lecturer can take appropriate actions as recommended or allowed by the university. The WS for SPAt Records also provides ability for “predicting” the maximum possible percentage that every student would be able to attend the class for the whole semester. As the “predicted” maximum percentage for any student keep decreasing, the relevant cell on column “Max Possible %  $\sqrt{}$ ” in the WS for SPAt Records changes its color automatically thus alerting the lecturer for taking necessary actions.

UNITEN academic regulation stated that students can be barred from attending further classes, continuous assessments, and the FE when their attendances are less than 80% [2]. In practice, before the students are barred, enough warnings should be given so that the students can take necessary actions not to miss further classes. By monitoring the pattern (of attend and absent) indicated in the WS for SPAt Records, warnings can be sent to students when they are observed to be missing from the classes for 3 times or more without acceptable reasons. The warnings help reduced students from missing the classes, and at the same also sending the message to the students that the lecturer is serious about attendance to the class. Action to bar students may be taken when they keep missing from the classes after earlier warnings and at the same time the maximum possible percentage of their attendances are “predicted” to be far below the permitted level. The drastic action of barring the students is not necessary when the reasons for not attending the classes are reasonable and acceptable.

All actions taken (such as to give warning to the students, or to bar them) can also be noted or recorded in the WS for SPAt Records.

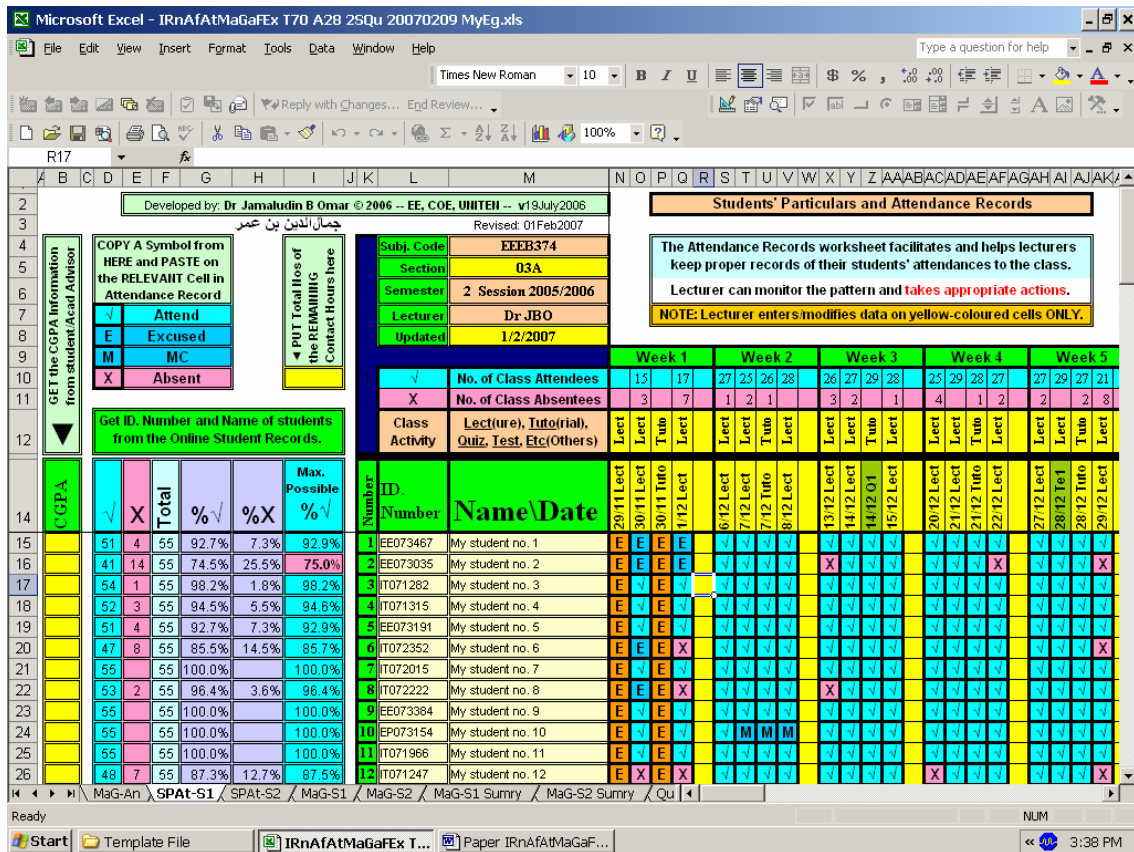


Fig. 1. Worksheet for Students' Particular and Attendance Records.

### 2.2. WS for Marks and Grading (MaG) Records

The WS for MaG Records, as shown in Fig. 2, is used to record marks for all assessment activities (usually called as CW) excluding quizzes performed before the FE. The assessment activities are assessments related to the course which may include final exam, test, quiz, assignment, project, term paper etc. Individual full mark and percentage for each assessment are specified using a WS called WS for Marks and Grading Analysis (refer to section 2.6). This information are linked and reflected in each WS for MaG records.

After relevant data are entered after each assessment activity, the WS for MaG Records will calculate and produce the latest total mark for CW. When scores for FE are entered in the WS for Final Exam Marks Records (refer to section 2.4), the WS for MaG Records will calculate and also produce the overall total marks obtained by the students throughout the entire course duration. Based on grading criteria using letter grades, as specified in the WS for Marks and Grading Analysis, letter grades obtained by individual student are also automatically produced, as shown in Fig. 3.

Although the letter grades are automatically produced based on the overall total marks and the grading scale described, lecturer can still able to overwrite the letter grades to be awarded to students.

Perhaps, the reasons may be, due to the overall total marks are very close to the next better letter grade and the attendance by the students were very good, the students can be considered the next better letter grades. Human touch is required here! This facility is provided basically for the lecturer to assign other letter grades which are used but seldom, such as letter grade BS (Incomplete), LU (Pass), GA (Fail) and TD (Drop) which are used at UNITEN. The lecturer can also let the TF to round up to next integer value of the total marks, which in turn may also help upgrade few letter grades for students whose marks are within 1% of the next better letter grades.

Several important information from the WS for MaG Records are automatically copied and summarized into another WS called Students Mark and Grade, refer to Fig. 4. This is actually a report prepared according to the requirement by College of Engineering UNITEN, where lecturers need to submit when they are submitting the hardcopy of the result. This report is to be used during Exam Board meeting. This type of report is usually required to be submitted to the evaluator during the accreditation visit, as evident when EE Department was preparing for Institute of Engineering and Technology (IET) United Kingdom accreditation exercise in the middle of 2007.

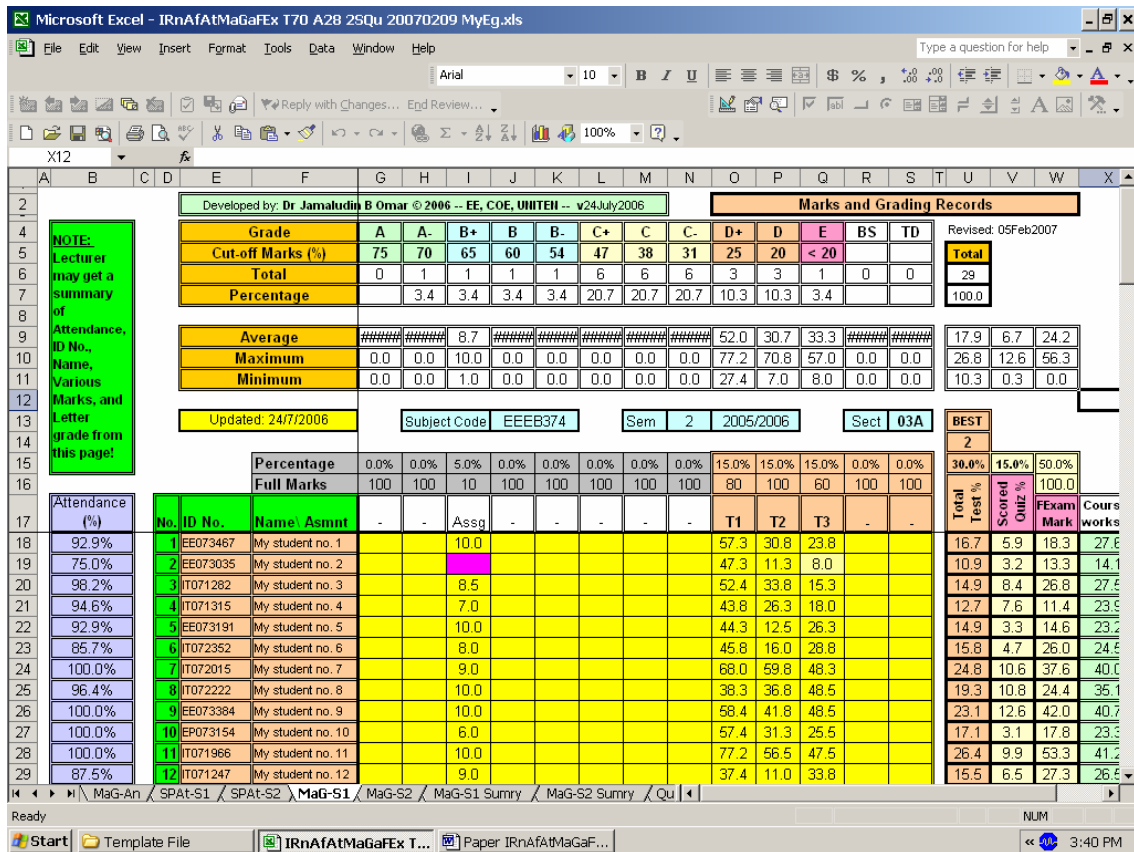


Fig. 2. Worksheet for Marks and Grading Records.

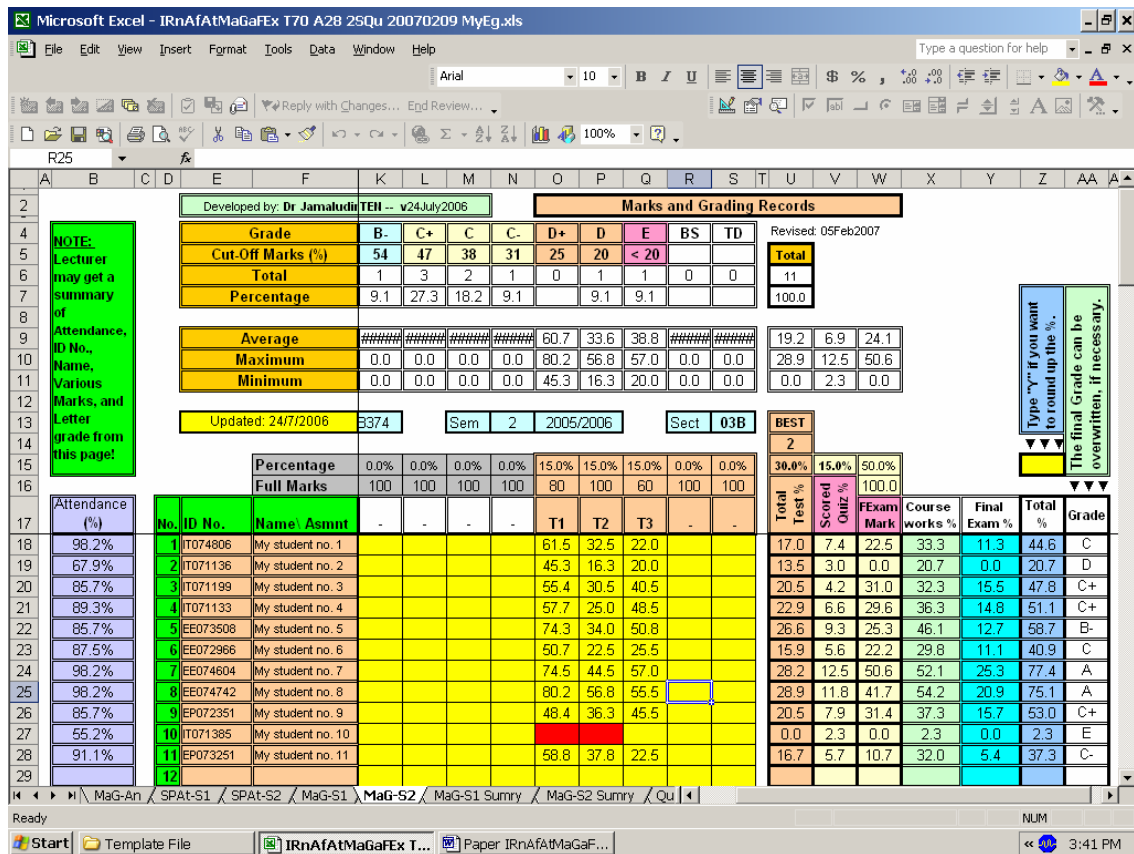


Fig. 3. Letter grades produced by the WS for MaG Records.

Developed by: Dr Jamaludin B Omar © 2006 -- EE, COE, UIITEH -- v06Feb2007							
Grade	A	A-	B+	B	B-	C+	C
Cut-Off Marks (%)	75	70	65	60	54	47	38
Total	0	1	1	1	1	6	6
Percentage		3.4	3.4	3.4	3.4	20.7	20.7
Grade	C-	D+	D	E	BS	TD	
Cut-Off Marks (%)	31	25	20	< 20			Total
Total	6	3	3	1	0	0	29
Percentage	20.7	10.3	10.3	3.4			55.2
Subject Name	Microprocessor Systems						
Subject Code	EEEE374						
Academic Year	2005/2006						
Semester	2						
Section	03A						
Name of Lecturer	Dr JBO						
Updated: 24/7/2006	Students Mark and Grade						
Attendance (%)	No.	ID No.	Name of Student	Course works %	Final Exam %	Total %	Grade
92.7%	1	EE073467	My student no. 1	27.57	9.15	36.72	C-
74.5%	2	EE073035	My student no. 2	14.05	6.65	20.70	D
98.2%	3	IT071282	My student no. 3	27.54	13.40	40.94	C
94.5%	4	IT071315	My student no. 4	23.86	5.70	29.56	D+
92.7%	5	EE073191	My student no. 5	23.21	7.30	30.51	D+
85.5%	6	IT072352	My student no. 6	24.45	13.00	37.45	C-

Fig. 4. Worksheet for Students Mark and Grade.

### 2.3. WS for Quiz Marks (QuM) Records

The WS for QuM Records is similar to the WS for MaG Records but it only records marks for quizzes. Records for up to 14 quizzes can be kept in this WS, with assumption that there is one quiz conducted for every week in a semester consists of 14 weeks. For final calculation of contribution from the quizzes to the percentage for the grading, lecturer has options to select contribution either from all quizzes conducted during the semester or take only a certain number of best scored quizzes from the total number of quizzes conducted. This can be done using the WS for Marks and Grading Analysis (refer to section 2.6).

### 2.4. WS for Final Exam Marks (FEM) Records

Details of mark for every question in the FE scored by every student during the FE are entered into the WS for FEM Records. This WS will mainly provide a summary of the class average mark, the class maximum mark, the class minimum mark, the number of students scored same or above the class average mark, and the number of students scored

below the class average mark. In conjunction with the WS for Analysis of Final Exam Marks (refer to section 2.5), the WS for FEM Records will also displays the statistics from the same class who scored same or above the overall average mark as well as below the overall average mark. Fig. 5 shows the WS for FEM Records.

Total marks scored by students in this WS is also analyzed and ranked. Information about 5 best, 5 medium and 5 lousy scorers are summarized in another WS named WS for Final Exam's 5 Best, Medium, Lousy Marks (FE 5BML). Lecturer can use the information from the WS for FE 5BML to pick the answer scripts and keep them in the course portfolio for accreditation purposes. Picking 5 best, 5 medium and 5 lousy answer scripts from the final exam is normally one of the procedure required during the accreditation process and also during checking by external examiner; for the purpose of ensuring that the questions in the final exam and their model answers covered the syllabus adequately as well as the quality of marking the answer scripts was performed with the same standard for all students.

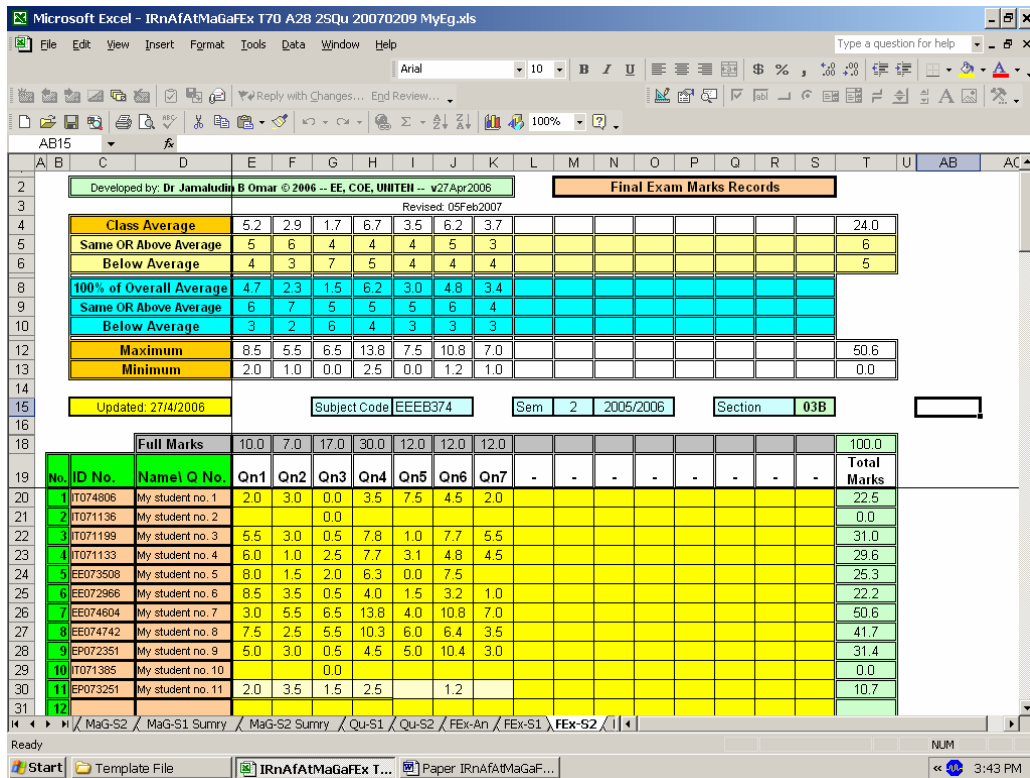


Fig. 5. Worksheet for Final Exam Marks Records.

### 2.5. WS for Analysis of Final Exam (FEx-An) Marks

Lecturer enters allocated full marks for each question in the FE using the WS for FEx-An Marks, as shown in Figure 6. Every “big” question (e.g. Question 1, 2 etc) may be divided further into smaller questions (such as Question 1a, 1b, 2a, 2b etc) according to Bloom’s cognitive level or course outcome (CO) number of a particular question. Bloom’s cognitive level and CO number are related to OBE implementation, where assessment can be made toward the achievement of the program educational objectives and program outcomes. Up to 15 smaller questions can be classified according to Bloom’s cognitive level or CO number in the WS for FEx-An Marks. From these data, the WS for FEx-An Marks summarizes how much (in %) a particular Bloom’s cognitive level or CO number is covered by the FE.

The WS for FEx-An Marks also summarizes further the summaries of the class average mark, the class maximum mark, the class minimum mark, the number of students scored same or above the class average mark, the number of students scored below the class average mark from separate classes given by the WS for FEM Records, to produce overall average mark, overall maximum mark and overall minimum mark for all classes in the course. The information is produced for every question in the final exam, see Fig. 6.

Lecturer may then make decision whether to exclude a particular question found, perhaps, to be tough for students to answer in the FE by observing

the full marks for each question and comparing it with the overall average mark and/or the overall full mark for all the classes.

To assist the lecturer further, the WS for FEx-An Marks also automatically calculates “adjusted full marks” based on the overall full mark, assigned minimum cut-off mark for letter grade “A” as set in the WS for Marks and Grading Analysis (refer to section 2.6), and the allocated full mark for each question in the FE. The lecturer may decide to use the “adjusted full marks” if the performance of students (including the bright one) for many questions are far below the expected level.

With both facilities, i.e. to exclude certain questions and to use “adjusted full marks”, a fair assessment may be provided to the students. They may had a tough time before the FE for that particular course, for example having other tough exams previously or had little time to recover from the previous exam paper to prepare for the FE of this course. So, these facilities may help students (perhaps a little bit) in providing a fair assessment to them.

With the facilities, the actual total marks for the FE may not be as initially allocated in the question paper. This change in the actual total marks will be copied and used in the WS for Marks and Grading Analysis, which in turn will be copied and used in all the WS for MaG Records. With the actual total marks for the FE is known, a correct letter grades will be produced in the WS for MaG Records, which in turn will be copied and analyzed in the WS for MaG-A



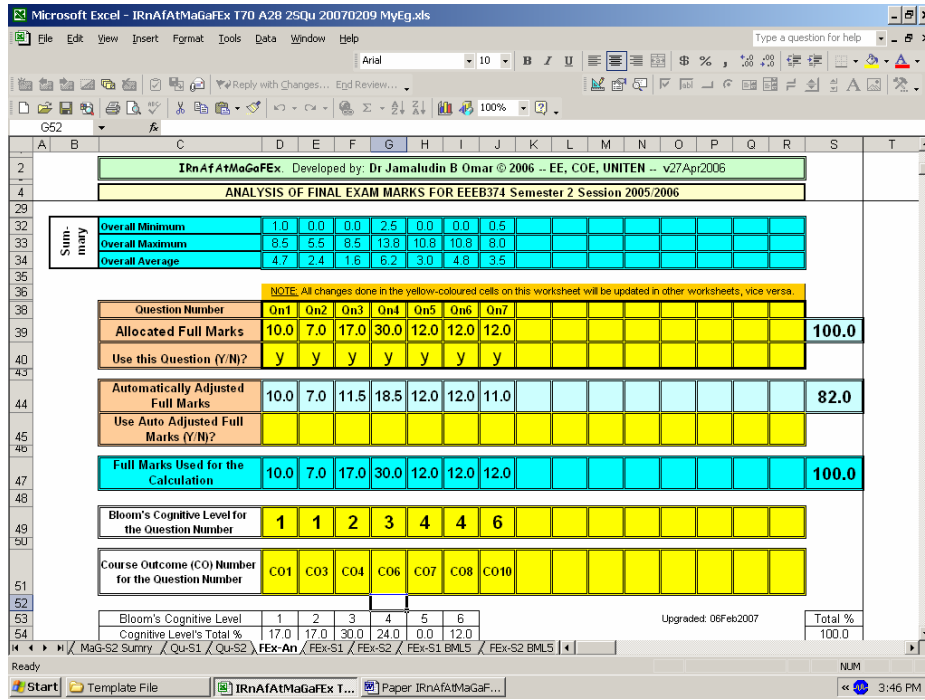


Fig. 6. Worksheet for Analysis of Final Exam Marks.

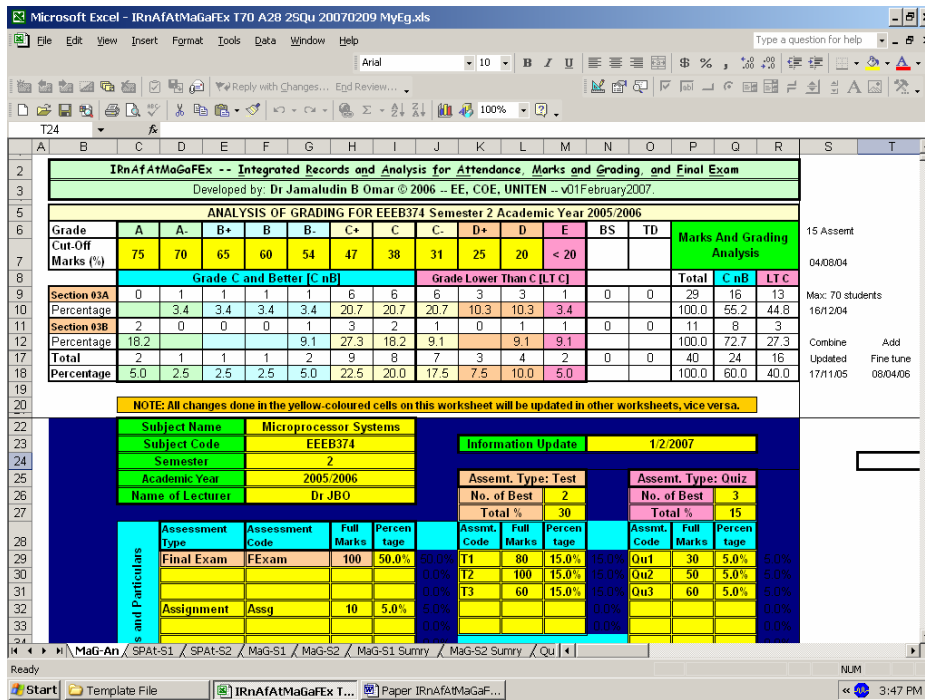


Fig. 7. Worksheet for Marks and Grading Analysis.

2.6. WS for Marks and Grading Analysis (MaG-An)

The WS for MaG-An, as shown in Fig. 7, provides grade analysis for all classes in the same course. Up to 2 classes can be handled and analyzed by the WS. The WS shows percentages for each letter grade for every class and also summarized the performance for all classes. Lecturer may use this information to do further adjustment in order to produce the required or accepted result for grade

distribution of the course. One way of doing the adjustment is perhaps by setting cut-off marks for the letter grades to specific values. Lecturer can do this manually by entering the required cut-off marks in relevant cells in the WS. Lecturer may enter number for each cell, or enter a number on one particular cell and use formulas for other cells.

With the WS for MaG-An also, the lecturer can enter full mark and percentage for every assessment method in the CW. Altogether, up to 28 assessment

methods can be handled. Lecturer is also able to specify to select the number of best tests from a total of 5 tests and the number of best quizzes from a total of 14 quizzes.

There are other information related to the course that the lecturer should enter in the WS for MaG-An, which are subject name, subject code, semester, academic year and name of the lecturer. These data will be used in other worksheets appropriately.

### 3. Frequency of data entry

Any dedicated software developed for a specific application is useless unless it is regularly updated with current data. The same thing applies to this TF, where lecturer needs to:

- a) Enter data related to the course at least once in the WS for MaG-An, perhaps at the beginning of the semester.
- b) Enter particulars of students at least once in the WS for SPAt Records for every class. These particulars will be copied to other worksheets for the same class as required.
- c) Enter and update data about attendance in the WS for SPAt Records perhaps once a week. With this updating, lecturer can monitor the pattern of attended and missed classes for every student in the class and take appropriate action, as required.
- d) Enter and update data in the WS for MaG Records after every assessment (excluding quiz) was over and marked.
- e) Enter and update data in the WS for QuM Records after every quiz was over and marked.
- f) Enter data in the WS for FEM Records after the FE was over and marked.

With the FE result analyzed in the WS for Analysis of FE Marks, lecturer may need to tweak or use facilities in the WS for MaG, the WS for FEx-An Marks, and also the WS for MaG-An in order to obtain the best and acceptable result possible.

### 4. Advantages of IRfAtMaGaFEx

Among advantages of the TF are:

- a) Lecturer can keep properly records for attendances, marks for CW, and scores for the FE in one place in softcopy. This is a very important task in OBE. The records are handy and can be easily accessed when required.
- b) Calculation of letter grades awarded to students at the end of the semester is done automatically. However, the lecturer can still interfere with the automatic production of letter grades and able to overwrite the grades awarded when necessary.

- c) By monitoring patterns of attendances by students regularly, lecturer can take earlier actions to warn students when their attendances are poor. Failing to rectify the situations, after that students may be barred from coming to further lectures, taking other assessments and sitting in the final exam. All actions can also be recorded in the TF. Warning actions help reduce truancy by students.
- d) The author had found (when testing the TF) that the WS for FEM Records is also useful for counterchecking "manual" addition of the total marks done on the answer scripts. Any error in addition done manually can be corrected when the score for every question is entered into the WS for FEM Records and calculated using Microsoft Excel<sup>®</sup>.
- e) Data in softcopy can be easily manipulated to produce reports in any form required, either by department or college.

### 5. Conclusion

The **IRnAfAtMaGaFEx** was developed to facilitate proper record keeping of attendances, marks for course works, and marks for the final exam in softcopy. The template file is able to fulfill these tasks correctly and efficiently, and at the same time able to help lecturers make decisions and take appropriate actions as necessary. However, a backup copy of the template file should be archived on other storage medium, such as CD-ROM or thumb-drive, in order to prevent the data being lost in case the hard disk on PC is corrupted

### Acknowledgements

The motivations for further development of **IRnAfAtMaGaFEx** were due to interests, feedbacks and suggestions from lecturers in the College of Engineering UNITEN and their willingness to try and use the template file for managing their courses after the author had shared the earlier version of the template file with them.

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## Utilization of Simulation for Training Enhancement

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### Abstract

Engineering system design, operation and maintenance has been handled for a long time through mathematical and real time models. The advent of computers, multimedia age and improvement in visualization has further proved the reality of fact that picture speaks more than words; also research in education and training has proven that visualization has great effect in improving learning. The complexity of real world situation of engineering education has obvious limitation of instructional presentation and training. Simulation gives result from theoretical representation of complex phenomena when hardware for the task is lacking, or in situations when enough time is not available for explanation. This paper will discuss, opportunities brought about by simulator as a tool in the training and certification of Malaysian Maritime Academy cadets training program. The usefulness of simulators in continuous education program to amplify and enhance competency based education and instructional training to meet goals of safety, cleaner ocean and protection of marine environment will be highlighted. The paper will also present the potential of simulators as training tool in other field of knowledge for enhanced outcome and competency based education.

**Keywords:** simulation; engineering; competency; complexity; enhancement; safety; education; training

### 1. Introduction

The world of man and the quest for knowledge to facilitate human activities including developing things that surround us has gone through various phases of development. The early man, used memorization as a tool, and wrote information on leaves, trees and mountains to store knowledge which was to be passed to the next generation. The main tools for everything related to learning has likewise gone through various phases of change and the most significant of these changes has been the emergence of ICT in the last one decade. Today, the developments in ICT have greatly accelerated the pace of knowledge delivery and the Simulation-Based studies and training is one typical example of such an evolution.

Simulation refers to the application of computational models for the study and prediction of physical events or the behavior of engineered systems. The development of computer simulation has drawn resources from a deep pool of scientific, mathematical, computational, engineering knowledge and methodologies. From the depth of its intellectual development and wide range of applications, computer simulation has emerged as a powerful tool, one that promises to revolutionize the way research in engineering and science are conducted in the

twenty-first century. Simulation has long been identifies in several areas of knowledge and it is playing a remarkable role in promoting developments vital to the health, security, and technological competitiveness of the nation. Engineering and scientific communities have become increasingly aware that computer simulation is an indispensable tool for resolving a multitude of technological problems.

Basically, computer simulation represents an extension of theoretical science in that it is based on mathematical models. Such models attempt to characterize the physical predictions or consequences of scientific theories. With simulation engineers are better able to predict and optimize systems affecting almost all aspects of our lives and work, including our environment, our security and safety, and the products we use and export. The use of computer simulations in engineering science began over half a century ago, but only in the past decade or so has simulation theory and technology made a dramatic impact across the whole engineering fields.

That remarkable change has come about mainly because of developments in the computational and computer sciences and the rapid advances in computing equipment and systems. Clearly, the use

of simulation is quickly becoming indispensable for goal based engineering education.

Simulation is an important feature in engineering systems or any system that involves many processes. Most engineering simulations entail mathematical modeling and computer assisted investigation. Mathematical model used to dominate simulation world however mathematical modeling is not reliable and the incorporation of physical model often helped to improve today complex system simulation. The development and use of such frameworks require the support of inter-disciplinary teams of researchers, including scientists, engineers, applied mathematicians, and computer scientists.

Maritime industry due to its nature and need for safety to maintain Cleaner Ocean has institutionalized and incorporated opportunity offered by simulation to training of marine personnel to fulfill objective of having competent personnel to man the ships that sail the ocean of the world. Encouraged by belief that knowledge, understanding, application and integration which are requirement for outcome and competency based education could enhance traditional instruction delivery method, through incorporating audio visual and multimedia tools, led the IMO to adopt resolution to use simulation as part of STCW requirement. Simulation is thus becoming central to advancement in maritime competency based training and education as well as educational training in biomedicine, nanomanufacturing, microelectronics, energy and environmental sciences, advanced materials, and product development. And there is ample evidence that developments in these new disciplines could significantly impact virtually every aspect of human experience.

This paper explores potentials and prospects of incorporating simulation in engineering and science education structure. Good practice and experience enjoined by maritime industry including ALAM will be discussed. The authors will also discuss the core issues of simulation, the major obstacles to its development and the impact of simulation on training, educational and research.

## 2. Maritime simulation and simulators

Marine simulators bears similarity to flight simulators, which are used to train pilots on the ground in extreme hazard situations such as landing with no engine, pilot to crash aircraft without being hurt or complete electrical or hydraulic failures. The most advanced simulators have high-fidelity visual systems and hydraulic motion systems. However, marine simulators train ships' personnel, Simulators like these are mostly used to simulate large vessels. They consist of a replication of a ships' bridge, with operating desk, and a number of screens on which the virtual surroundings are projected. The complexity of shipping activities from design to operations training and maintenance remain one of the factors that have

made IMO to enact strong regulations to ensure safety at all times.

Due to new issues of imbalance in human activities and environmental behaviors, ship and its operating areas in closest proximity to ocean that cover two third of the world has further put maritime work a target by public and land based environmental agencies whose pressure has given IMO further challenges of protection of environment that has called for new way of doing things based on risk and proactive manner. Simulator is obviously one of the tools that fit in such proactive measures to prevent accidents as its consequence leads to serious environmental problems.

While International laws are best implemented and enforced through local authorities law, the performance and control are best achieved through third eyes. DNV is one such third eyes under classification society in maritime industry which has laid down some guidelines marine simulators. Certification of the simulators by DNV ensures that simulator systems have qualified personnel giving realistic and high quality simulator training conforming to SCTW requirement. Table 1 and 2 show approved STCW courses and DNV certified simulation institutions.

Table 1. STCW Courses

COURSE PROVIDER	CERTIFICATE NO.	COURSE TITLE	EXPIRY DATE	COUNTRY
Seagull AS	04/014	Assessor Training CBT	03.12.2007	NORWAY
	091/061214	ECDIS Training CBT	14.12.2009	
Nordic Crisis Management AS	005/050304	STCW Crowd Management Course	02.03.2008	DENMARK
Furuno INS Training Center	047/051122	ECDIS Training Course	22.11.2008	
Malaysian Maritime Academy Sdn Bhd (ALAM)	055/060306	Nautical Studies and Marine Engineering Courses	06.03.2011	MALAYSIA
NYK Ship Management PTE-LTD	102/070320	BRM Course	20.05.2010	SINGAPORE

Table 2. Approved simulators (manufacturers) – Source DNV classification

MANUFACTURER	CERTIFICATE NO	EXPIRY DATE	SIMULATOR TYPE	CLASS	COUNTRY
Kongsberg Maritime AS	011/060606	2007.12.06	Machinery Operation	A	NORWAY
	012/060606	2007.12.06	Cargo Handling	A	
	A-9616	2010.05.25	Bridge Operation	A	
Transas Ltd.	A-9641	2010.06.20	Bridge Operation	A	IRELAND
	A-9642	2010.06.23	Machinery Operation	A	
L-3 Communications MPRI	A-9335	2009.12.30	Machinery Operation	A	USA

However the use and the corresponding training program has been developed on ad hoc basis of individual training center working with many shipping companies where simulation is often inserted into existing program rather incorporating

simulation as part of the objectives. Neither has there been any standardization for simulation. The fact is that simulation itself does not train but its benefit to training comes from the way it is used, it become imperative to make part of training aim and objective that comes with education requirement. STCW was built on conventional approach that focus on knowledge to determine competency with oblivion to job task and performance in training that arise from reality of mismatch between training course and corresponding needs. The ability of simulation fidelity, producing real life task in a safe environment and provide mitigation option to this where simulation come in as fundamental tool to bridge gap between theory and application.

### 3. Marine simulation curriculum and training process

In maritime industry, IMO classified simulation under STCW amendment into the following groups:

Category 1 - Full mission capable of simulating full visual navigation including maneuvering.

Category 2 -Multitask - full mission capable of simulating full visual navigation excluding maneuvering ie radar simulator.

Category 3 -Limited task- capable of simulating environmental for limited extreme conditions.

Category 4 - Special task- capable of simulating maneuvering with operator outside the environment.

Simulation in STCW code is made of two parts, where:

Part A is mandatory and includes the minimum standards of competency for seagoing personnel, simulator used in both training and assessment. And the requirement for ARPA (Automatic Radar Plotting Aid - thus simulator equipment being used prior February 1, 2002 may be exempted at the discretion of parties involved).

Part B deal with guidance to those involved in education, training or assessing the competence under STCW provision concerning application of various safety and environmental regulation and conformity.

Maritime training is divided into two groups:

- i. License – This include experience trainee that undergo additional training designed toward improving their existing skill, performance and awareness. Such training includes: Watch keeping, ARPA, Control, Ship resources management, Ship team management, Emergency procedure, Ship handling, Vessel traffic management, Search and rescue, Area familiarization
- ii. Unlicensed- this involved cadets working towards first certificate of competency under standard structure program. Simulation application for this training includes: Watch keeping, knowledge of international

regulation, Communication, Radar, electronic navigation, main and auxiliary machineries.

Most of these courses are not actually mandatory, how good it will have been if shipping company could incorporate them in their program. Thus recent amendment of STCW recommendation for use of simulation is a significant stepping stone in this direction. The training should be designed by considering the following:

- i. Training need through identification of gaps between training, required knowledge, skills abilities and actual knowledge, skills and ability.
- ii. Specific training objectives which should include performance measurement
- iii. Training method including assessment weather simulation is required to achieve the objective
- iv. Total training program
- v. Experience of trainee
- vi. Level and type of simulation
- vii. Instructor qualification and experience
- viii. Effectiveness and benefit of the training

Once this is determined a scheme of work which includes: Aim and general objective, trainees and numbers, structure and schedule.

- i. Individual simulation exercise that include specific objective, planning, debriefing session and instruction to staff on methods of debriefing
- ii. Method of assessment

The instructional process itself required the following consideration: Instructional process, Scenario design, Use of control and monitoring station, and Debriefing technique.

Rational for simulation can be stressed out from the fact that traditional class room method of teaching that use tool like chalk, overhead projector, occasional use of video material to amplify training objective give unbalanced advantage to instructor to have direct control that may not entertain training participation. Adding simulation to curriculum and allow the instructor to fill gap between theory and practical could change this equation. Simulation is expected to have program where and when it will be effective and useful in operation. Apart from concentration on fidelity of simulation - the degree of realism of simulators and simulation learning process includes the following factors:

- i. The progression from easy to more complex and difficult task and operation
- ii. The involvement of more than one sense
- iii. The need to concentrate interest on single problems
- iv. The trainees control of his own activities and possible mistakes

Effectiveness of simulation based depends on the following attributes of simulation that add up to the advantage simulation has for the future of man and knowledge.

- i. Exceptional Bandwidth: The conceptual basis of materials modeling and simulation encompasses all of the physical sciences.
- ii. Elimination of Empiricism: A virtue of multiscale modeling is that the results from both modeling and simulation are conceptually and operationally quantifiable.
- iii. Visualization of Phenomena: The numerical outputs from a simulation are generally data on the degrees of freedom characterizing the model.
- iv. Prediction of the consequences of threats and Countermeasure responses -Extreme engineering processes such as structural responses, fluid transport of contaminants, power distribution, and transportation systems, as well as the response of the human population.

#### 4. ALAM's simulation and simulator experience

ALAM training towards a world class one stop maritime institution aims to deal with challenges of today and future through “ beyond competency “ partnership with DnV seaskill in order to add value of soft and hard skill required of marine personal and industry to conform with international local statutory requirements and often multi-national operations. ALAM simulation adds value to competence for ships staffs to be able to plan, define, develop and improve the competence of employees according to external requirements and established business goals to meet targets of safer, efficient operations, cleaner ocean and protection of marine environment.

DNV SeaSkill Standard for Competence under STCW focus on providing necessary tools and expertise to evaluate the competence of individuals, through test questions and practical assignments, in relation to specific jobs or positions with competence standards developed with the industry and outlining competence requirements for given positions; individuals may both be assessed and certified. The program also helps ALAM to recruit suitable mariners at suitable position good degree of reliability.

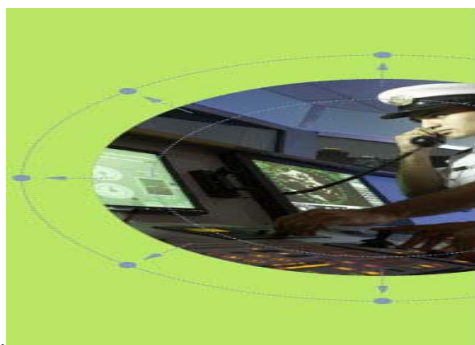


Fig. 1. ALAM's simulator.

ALAM has undertaken a major effort in cooperation with DnV to improve the professional competency importance of maritime vocational and qualification by basing them on standard of proficiency required in employment. Towards this end, ALAM simulation is used as required as part of competency assessment on the ability of trainee to perform on board ship according to standards. Thus it is very important to incorporate cost comparison for necessary differentiation. ALAM invest on what to be achieved through simulation training involve task analysis and performance criteria developed to meet trainee and employers needs, IMO and classification society requirements whose aim concentrate on competency training. However ALAM invest on what to be achieved.

ALAM simulator was built by Transas Marine USA, a simulator manufacturer known for building of state of the art simulators consisting of Transas Navi-Trainer Professional 3000 full mission ship simulator system with integrated GMDSS communications simulation capabilities, as well as ARPA/Radar simulator. Transas Marine's unique combination of simulation software, dedicated hardware (real ship controls) and commercial-off-the-shelf components, the simulator is an ideal tool in the training and certification of Maritime education programs. The ship simulator, IMO STCW training standards and the latest Det Norske Veritas 'Standards for Certification of Maritime Simulator Systems' to Class A as well as meet USCG. DnV has certification for simulators that meet the need of the marine industry quality training solutions.

Transas simulators are based on mathematical model that allows processes to be accelerated without detriment to physical realism at considerable reduced time. The simulations can be form under the following areas:

- i. Full mission Ship – Handling simulation
- ii. Engine room simulation
- iii. Cargo operations simulation

The simulator has diverse cargo types databases that facilitate selection and on almost all types of cargo for operation training. Cargo operation simulations include:

- i. Large Crude Oil Carrier (LCC);
- ii. Liquefied Petroleum Gas (LPG) Carrier;
- iii. Chemical tanker (CHT);
- iv. Liquefied Natural Gas (LNG) Carrier.

##### 4.1 Full Mission Ship-handling Simulator

The Full Mission Ship-handling Simulator (FMSHS) with capacity to simulate extensive exercise scenarios is certified by DNV as Class A Standard. Consisting of a single main bridge with nine high resolution projectors, 270° field of view visual scene (with a panning and tilting facilities to provide rear and over-the-side view), an extensive bridge mockup complete with a full complement of

bridge equipment, environmental effects (consisting of wind, water current, depth, and bank forces), and high-fidelity own ship and passing ship hydrodynamic effects, the system realistically presents the total marine scene.



Fig. 2. ALAM's Full Mission Simulator.

Three additional cubicle bridges with 120° field of view are similarly equipped to provide interconnected operation and total ship-handling interaction between the simulators. In addition, one of the cubicle bridges is equipped with a dynamic positioning system. With a library of more than a hundred geographic databases, 79 ship models and a facility to generate a new geographic database

#### 4.2 Engine room simulator

Built to DNV Class A specification, the Engine Room Simulator (ERS) consist of the machinery space, engine control room and a computer workstation laboratory. The machinery space is equipped with local operation stations to provide appropriate indicators and controls for local power plant control. Four 42" plasma screens provide an innovative 3D virtual reality of the engine room compartments, the machinery layout, and the physical realism of the ship environment.

The engine control room is equipped with main engine control console, diesel generator control console and main switchboard console to allow trainees to operate valves and machinery throughout the engine room. Realistic engine room sounds and alarms are also simulated in the engine control room to provide aural cues. Equipped with twelve (12) student workstations, the computer workstation laboratory provides trainees access to a wide variety of equipment and controls associated with the various power plant and auxiliary system and may be used for both individual and team instruction.

Five engine models provide trainees with comprehensive knowledge of major engine makers like MAN B&W, SEMT Pielstick, Wartsila Sulzer and Kawasaki Heavy Industry. When interconnected, the FMSHS will response in accordance with the

ERS models, which have been accurately modeled and validated.

#### 4.3 Liquid Cargo Operation Simulator

These are designed to conform to latest liquid cargo operation system found on modern ship, the Liquid Cargo Operation Simulator (LICOS) is equipped with twelve (12) student workstations that provide access to a wide variety of examples of liquid cargo operation functions and may be used for both individual and team training. Eight (8) of the workstations have two LCD monitors and the other four (4) workstations are fitted with four LCD monitors which may be configured as an oil terminal when integrated with the VLCC model for team training.



Fig. 3. ALAM's Liquid Cargo Operation Simulator.

The calculations of tanks, hull strength and ship loading in the simulator are carried out by the Load Calculator System, which is a real on-board Load Calculator. The Graphics User Interface (GUI) is optimized for familiarization with the entire system operating principles and for acquiring practical skills in equipment handling. The main tanker units are implemented as 3D objects, showing cross sections of individual assemblies. Computer animation is used to display the current processes.

Since operations by the bridge team on the main FMSHS will impact team operations of the ERS, and vice versa, the main Full Mission Ship-handling Simulator will be fully integrated with the Engine Room Simulator (ERS) to provide team training. When interconnected, the FMSHS response is in accordance with the ERS models, which have been accurately modeled and validated - making the ALAM Simulation Center a world-class simulator-based learning environment.

### 5. Benefits of simulation

Benefit offer by incorporating simulation in education are further amplified by the following:

- i. Simulation allows us to explore natural events and engineered systems that have long defied analysis, measurement, and experimental

- methodologies. In effect, empirical assumptions will be replaced by science-based computational models.
- ii. Simulation also has applications across technologies—from microprocessors to the infrastructure of cities.
  - iii. Simulation methods will lay the groundwork for entire technologies that are only now emerging as possibilities.
  - iv. Simulation will enable us to design and manufacture materials and products on a more scientific basis with less trial and error and shorter design cycles.
  - v. Simulation improves our ability to predict outcomes and optimize solutions before committing resources to specific designs and decisions.
  - vi. Simulation will expand our ability to cope with problems that have been too complex for traditional methods. Such problems, for example, are those involving multiple scales of length and time, multiple physical processes, and unknown levels of uncertainties.
  - vii. Simulation will introduce tools and methods that apply across all engineering disciplines—electrical, computer, mechanical, civil, chemical, aerospace, nuclear, biomedical, and materials science. For instance, all engineering disciplines stand to benefit from advances in optimization, control, uncertainty quantification, verification and validation, design decision-making, and real-time response.
  - viii. Simulator certification benefits training institutions seeking assurance on heavy investments result in optimal training conditions and marketing of simulator training centers services

In addition to this simulation also offer advantage of:

- Protection against Air Contaminants:
- Optimization of Infrastructures:
- Prediction of Long-Term Environmental Impacts
- Optimization of Emergency Responses
- Optimization of Security Infrastructures for Urban Environments
- Planning of countermeasures
- Prediction of treat and countermeasure responses

### *5.1 Educational strategies of the future for Engineers and Scientists*

Our time has seen significant dramatic expansion of the knowledge base required to advance modern simulation. The expansion ignores the traditional boundaries between academic disciplines, which have long been compartmentalized in the rigid organizational structures of today's universities. The old silo structure of educational institutions has become an antiquated liability. It discourages

innovation, limits the critically important exchange of knowledge between core disciplines, and discourages the interdisciplinary research, study, and interaction critical to advances in simulation.

Today's demands nonetheless call for:

- i. Citadel of learning to change their organizational structures to promote and reward collaborative research that invigorates and advances multidisciplinary science. It has also become a matter of need for universities to implement new multidisciplinary programs and organizations that provide rigorous, multifaceted education for the growing ranks of simulation trainers and researchers.
- ii. Simulation need to be incorporated in our educational discipline as a engineering tool and proponent life-long learning opportunity
- iii. Simulation requires a broad range of interdisciplinary knowledge that tomorrow's engineers and scientists with substantial depth of knowledge in computational and applied mathematics, as well as in their specific engineering or scientific disciplines. Participation in multidisciplinary research teams and industrial internships will give students the broad scientific and technical perspective, as well as the communication skills that are necessary for the effective development and deployment of simulation education.
- iv. Integrating simulation into the educational system will broaden the curriculum for undergraduate students. Undergraduates, moreover, will have access to educational materials that demonstrate theories and practices that complement the traditional experimental and theoretical approaches to knowledge acquisition.
- v. Simulation will also provide a rich new environment for undergraduate research, in which students from engineering and science can work together on interdisciplinary teams.
- vi. As in any entrenched culture, change is hard to come by. To change the culture of separate disciplines in our universities will require well directed, persistent, and innovative government initiatives.
- vii. The necessary changes in educational structure will come without strong directives from leaders from academia, industry, and government laboratories.
- viii. And provide funding for multidisciplinary graduate education programs that offer students simulation integrated approach of team research and career development.



## 5.2 Challenges

There are challenges, that need to be faced regaining multiscale and multi-physics modeling, real-time integration of simulation methods with measurement systems, model validation and verification, handling large data, and visualization for discipline that want to incorporate it for the first time. It is only by these challenges involved in resolving open problems associated with simulation. Significantly, one of those challenges is education of the next generation of engineers and scientists in the theory and practices of simulation in every subject.

There is no doubt that a lot of money will be involved, and research will be required for specific feed where simulations need to be plugged into the program, But the risk worth taken research to exploit the considerable promise of Simulation in education. Therefore it also necessary to provide new cyber - infrastructure that will allow teacher and scientists to pursue Competency and Objective Based Education and research in new ways and with new efficiency” by utilizing:

- i. high-performance, global-scale networking,
- ii. middleware,
- iii. high-performance computing services,
- iv. observation and measurement devices, and
- v. improved of interfaces and visualization services.

Building simulation center require serious consideration of feasibility of developing a parallel programs in simulation that interfaces to multiple divisions of engineering education in concert with cyber infrastructure.

Progress in simulation will also require the creation of interdisciplinary education teams that work together on leading-edge simulation problems. A sweeping overhaul of our educational system towards simulation and initiative for change will not likely come from academia alone; it must be encouraged by the engineering and scientific leadership and throughout the organizational structure of our universities as well as simulation institution in industry. The payoffs for meeting these challenges are profound. We can expect dramatic advances on a broad frontier of knowledge and practice.

The following list is a summary of its current limitations:

- i. The development of models is very time consuming, particularly for geometries of complex engineering systems such as ships, automobiles, and aircraft. Moreover, the determination of material properties often requires extensive small-scale testing before simulation can be started, especially if statistical properties are needed. This testing also lengthens the time to obtain a simulation and hence the design cycle.

- ii. Methods are needed for linking models at various scales and simulating multi-physics phenomena.
- iii. Simulation is often separate from the design optimization process and cannot
- iv. Simultaneously deal with factors such as manufacturability, cost, and environmental impact.

## 5.3 Overcoming the challenges of now

As design processes increasingly rely on computer simulation, validation and verification procedures will become increasingly important. Although some efforts have been made at providing validation benchmark problems for linear analysis, nonlinear simulation software has not been subjected to extensive validation procedures. Clearly, a basic understanding of verification and validation procedures is urgently needed. After all, to be useful, the simulation tools used by industry and defense agencies must provide reliable results. Furthermore, since many real-world phenomena are not deterministic, statistical methods that can quantify uncertainty will be needed. Design optimization is also in its infancy, and it too has many obstacles to overcome. The constraints on the optimization of a product design relate to manufacturability, robustness, and a variety of other factors. In order to be effective for engineering design, optimization methods must be closely coupled with simulation techniques.

Overcoming the barriers behind simulation will require challenges and progress in our basic understanding and in the development of powerful new methods. Among these challenges are the following:

- i. Multiscale methods that can deal with large ranges of time and spatial scales and link various types of physics.
- ii. Methods for computing macroscopic phenomena, such as material properties and manufacturing processes, in terms of subscale behavior.
- iii. Effective optimization methods that can deal with complex integrated systems, account for uncertainties, and provide robust designs.
- iv. Frameworks for validation, verification, and uncertainty qualification.
- v. Methods for rapidly generating models of complex geometries and material properties.
- vi. Multiscale methods will provide extensive benefits.

The following are a few of the areas requiring development:

- i. Quantitative models of the processes to be simulated must be developed. For many of those processes, models of some level of fidelity already exist, or they are being developed for narrower engineering purposes.

- ii. A comprehensive simulation system is required that integrates detailed models of a wide range of scales. The comprehensiveness of the simulation system is a requirement if simulation in education applications is to simulate multiscale complex systems. Some of the issues are generic, but others are problem specific.
- iii. New models of exceptional fidelity are required. The development and validation of such models entail the acquisition of data of extraordinary detail.
- iv. A better understanding of the role of uncertainty is required. Some degree of uncertainty is inevitable in the ability of a model to reflect reality and in the data the model uses. We need to find ways to interpret uncertainty and to characterize its effects on assessments of the probable outcomes.

Generally, however, we still lack a fundamental understanding of what constitutes an optimal design and how to find it in a complex multi-criteria design environment. Once optimization methods are developed that can deal with these complexities, we can expect to see chemical plants, automobiles, laptop. Simulation has the potential to deliver, within a short design period, designs that are optimized for cost performance and total impact on the environment. The rewards of meeting those challenges are great: enhanced efficiency, security, safety, and convenience of life in the digital, infrastructure, city and ecosystem, a social infrastructure of unparalleled efficiency, rational responses to natural events and optimal interactions with natural environments.

## 6. Conclusion

The need for Simulation based education is at a crossroads in our global technological development. For almost half a century, developments in mathematical modeling, computational algorithms, and the technology of data intensive computing have led to remarkable improvements in the health, security, productivity, quality of life, and competitiveness of nations. We have now arrived at an historic moment where simulation is the key elements for achieving progress in engineering and science. The challenges of making progress, however, are as substantial as the benefits. We must, for example, find methods for linking phenomena in systems that span large ranges of time and spatial scales. We must be able to describe macroscopic events in terms of subscale behaviors. We need better optimization procedures for simulating complex systems, procedures that can account for uncertainties. We need to build frameworks for validation, verification, and uncertainty quantification.

In today's competitive world, in order to be at the frontier of knowledge it has become important to explore the possibility of incorporating in our engineering educational system to reflect the multidisciplinary nature of modern engineering and to help students acquire the necessary modeling and simulation skills. Thus simulation required good computer speed, funding and efficiency. However, this barrier can be solved by promoting interaction between multiple disciplines that fit naturally and strategically in parallel with or within the Cyber infrastructure framework.

Simulation definitely has the potential to deliver designs that are optimized for cost performance and their total impact on the environment (from production to disposal or recycling), all within a short design cycle. This achievement is not possible, however, simply by extending current research methods and taking small, incremental steps in simulation based education development. The barriers to the realization of simulation in education relate to our entire way of conducting research development and educating engineers. Other field of engineering can surely use experience of the shipping industry as a guide to incorporate simulation in education work.

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## Appendix

Table 3. Simulation Product Types

SIMULATOR CENTRE	CERTIFICATE NO	EXPIRY DATE	SIMULATOR TYPE	CLASS	COUNTRY
Maritiem Instituut 'Willem Barnentsz'	002/060222	2010.05.31	Bridge Operation	A	NETHERLANDS
	003/060220	2010.05.31	Bridge Operation	A	
	004/060220	2010.05.31	Machinery Operation	A	
	005/060220	2010.05.31	Cargo Handling	A	
STC B.V	006/060223	2010.05.10	Bridge Operation	A	NETHERLANDS
	007/060223	2010.05.10	Bridge Operation	A	
	008/060223	2010.05.10	Bridge Operation	A	
	009/060223	2010.05.10	Bridge Operation	A	
Malaysian Maritime Academy (ALAM)	001/060217	2011.02.17	Bridge Operation	A	MALAYSIA
Sperry Marine Training Centre	010/060523	2011.05.23	Bridge Operation	C	GERMANY
	SSP-103	2006.06.30	Bridge Operation	A	
	SSP-104	2006.06.30	Bridge Operation	C	
	SSP-105	2006.06.30	Bridge Operation	C	
	SSP-106	2006.06.30	Bridge Operation	C	
Evergreen Seafarer Training Center	SSP-202	2006.06.30	Machinery Operation	A	GERMANY
	SSP-203	2006.06.30	Machinery Operation	X	
	SSP-301	2006.06.30	Radio Communication	B	
National Kaohsiung Institute of Marine Technology	SSP-204	2008.05.23	Machinery Operation	A	TAIWAN
	SSP-109	2006.07.25	Bridge Operation	X	
	SSP-115	2008.05.23	Bridge Operation	A	
	SSP-118	2008.05.23	Bridge Operation	C	
National Kaohsiung Marine University	SSP-303	2007.10.11	Radio Communication	A	TAIWAN
	A-9467	2010.02.14	Cargo Handling	A	
National Taiwan Ocean University	SSP-205	2008.05.23	Machinery Operation	A	TAIWAN
	A-9368	2009.12.06	Cargo Handling	A	
	013/060825	2011.07.21	Bridge Operation	C	
	SSP-113	2007.10.10	Bridge Operation	A	
	SSP-116	2008.05.23	Bridge Operation	C	

Table 3. Simulation Product Types...(cont.)

Split Ship Management Ltd.	SSP-110	2006.10.31	Bridge Operation	A	CROATIA
MPA Integrated Simulation Centre of Singapore	SSP-111	2007.06.28	Bridge Operation	A	SINGAPORE
	SSP-112	2007.06.28	Bridge Operation	A	
Haeyong Maritime Services Co. Ltd.	014/061020	2011.09.11	Bridge Operation	B	KOREA
NYK Shipmanagement Pte. Ltd. Training Centre	015/061120	2011.11.20	Bridge Operation	A	SINGAPORE
	018/070323	2012.3.23	Cargo Handling	A	
Maersk Training Centre AS	016/061212	2011.11.15	Cargo Handling	A	DENMARK
Changi Naval Training Base FMSS Centre	016/061205	2011.12.05	Bridge Operation	A	SINGAPORE
Warsash Maritime Academy	017/070228	2012.03.01	Cargo Handling	A	UNITED KINGDOM

## Interactive Learning Framework for Dynamic Modelling and Control of a Flexible Beam Structure

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### Abstract

This paper presents the implementation of an interactive learning environment for dynamic simulation and active vibration control of flexible structures. The work is aimed to facilitate the learning process of the subject area through the development of an interactive environment that can help users to simulate and visualise behaviour of flexible structures with given physical characteristics, to test and validate controller designs. Furthermore, the environment allows users to execute such processes repeatedly in a friendly and easy manner. Simulation algorithms based on finite difference scheme in characterizing the dynamic behaviour of one-dimensional flexible beam structures with different boundary conditions are incorporated. Controller design strategies comprise of parametric and non-parametric are integrated within this framework. The design and implementation of the interactive learning system incorporating the simulation algorithms, modelling and control strategies, are developed using MATLAB. The environment allows the user to specify the boundary conditions and physical properties of the structure including the dimensions and material type, and provides the response of the structure to user-specified disturbances in the time and frequency domains. The result of the simulation is further utilized in the modelling and control of the specified flexible beam structure. The environment thus developed forms a useful interactive and user-friendly learning and education facility.

**Keywords:** interactive learning; active vibration control; flexible beam, parametric modeling; non-parametric modelling

### 1. Introduction

Flexible structures are utilised in a wide range of engineering systems, for example, in civil engineering applications include skyscrapers and bridges, in aerospace structures include propellers, aircraft fuselage and wings, satellite solar panels and helicopter blades and in electro-mechanical systems include turbo generator shafts, engines, gas turbine rotors and electric transformer cores (Hossain, 1996). This is due to the advantages such structures offer in comparison to their rigid and bulky counterparts, including fast response, low energy consumption, reduced mass and low cost (Tokhi and Azad, 1995).

Flexible structure systems however are known to exhibit an inherent property of vibration when subjected to disturbance forces, leading to component and/or structural damage (Tokhi and Leitch, (1992). Therefore, the purpose of vibration control in flexible structures is to dampen the response of the structure to external excitation. In all cases there are the alternatives of passive or active control solutions. Active vibration control consists of artificially generating cancelling sources to destructively interfere with the unwanted source and thus result in a reduction in the level of vibration at desired

location(s) (Tokhi and Leitch, 1992). In this context, and due to time-varying phenomena in practical applications, adaptive control techniques are preferred.

Adaptive systems are designed to modify their behaviour in accordance with the changing properties of controlled processes and their signals. An adaptive mechanism is characterised by two complementary processes; identification and control. In the process of identification a suitable model is developed that exhibits the same input/output characteristics as the controlled process (plant). In the process of control a control process is determined, implemented and tested on the plant on the basis of the identified model and control/performance objective (Tokhi and Veres, 2002).

The simulation algorithms characterising the dynamic behaviour of one-dimensional (1D) and two-dimensional (2D) flexible structures has been developed by Mohd Hashim and Mat Darus using finite difference (FD) method in 2001 and 2002 (Mohd. Hashim *et al.*, 2002; Mat Darus and Tokhi, 2001). These simulated algorithms will be used as evaluation and verification platform for modeling and control of the flexible beam structures presented in this paper.

The power of digital computation has had major positive influence on engineering education. As early as 1974, an increasing interest in interactive computer programs may be noticed at almost all control institutes. Mostly of these programs are developed by the institutes themselves for educational purposes or as a tool for researchers (Lemmens and Van Den Boom, 1979). Lemmens and Van Den Boom (1979) highlighted that there are several converging reasons for constructing an interactive system. Among them, in control theory specifically to instruct students in aspects of modern control theory that need the use of computers, to create a library facility for control software and provide means by which results of one program can be used or analysed by another, to provide the possibility to compare methods eg. identification methods and also to save students' time by providing existing software which obviates time consuming calculations and graph plotting. Hough and Marlin (2000) stated that the use of simulation is particularly effective in process control education because of the complex behaviour of control systems. More work on computer-based interactive learning particularly in process control has been reported by a number of researchers (Book *et al.*, 2002; Jovan and Petrovic, 1996).

The design and implementation of an interactive system incorporating the simulation algorithms, modelling and control strategies, and a graphical user interface, are described using Matlab. The environment allows the user to specify the boundary conditions and physical properties of the structure, and provides the response of the structure to user-specified disturbances in the time and frequency domains and in 2D and 3D views. The result of the simulation is then utilized in the modelling stage, and then in development of suitable controllers for the flexible beam structure. Several parametric and non-parametric controller design strategies are investigated for vibration suppression of the flexible beam structure. The performance of the controller is described in time and frequency domains for analysis and further study.

This paper presents the development of an interactive learning environment for dynamic simulation and active vibration control (AVC) of flexible structures. The work aims to facilitate the learning process of the subject area through the development of an interactive environment that can help users to simulate and visualise behaviour of flexible beam structures with given physical characteristics, as well as to test and validate controller designs, and furthermore, to allow users to execute such processes repeatedly in a friendly and easy manner.

## 2. Design of the interactive learning environment

This section will discuss the design of the system by highlighting the main components of the

environment. A flowchart of the system is shown in Fig. 1, and the corresponding system inputs are described in Fig. 2.

The system comprises three main sub-menus, where each sub-menu represents the process that takes place in the design of controller in the AVC of a specified flexible structure. The controller design law is described in (Hossain, 1996; Tokhi and Leitch, 1992; Tokhi and Veres, 2002). The sub-menus are simulation, identification and control stage. Each is discussed below.

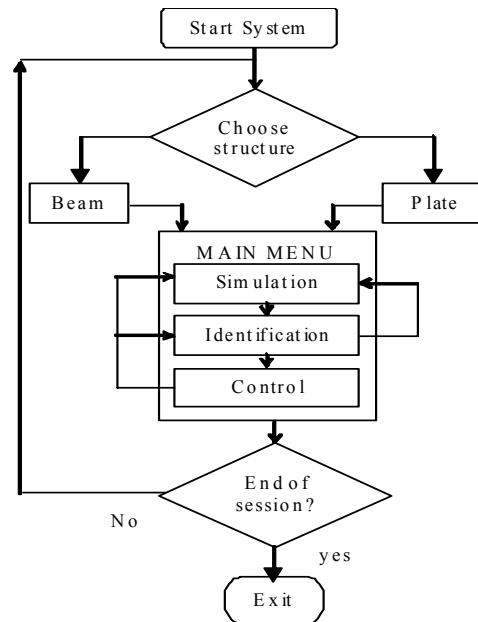


Fig. 1. Flowchart of the system.

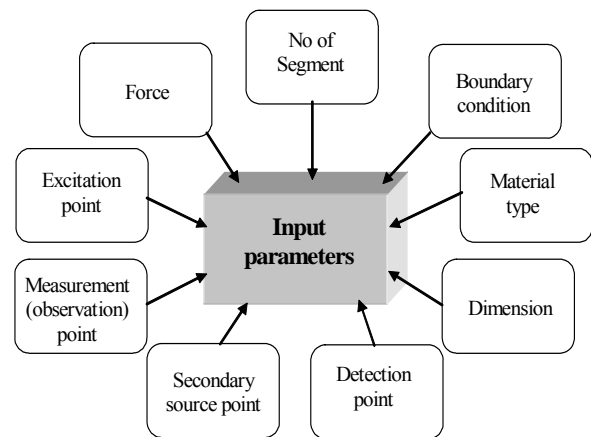


Fig. 2. System input.

### 2.1. Simulation

A flowchart and corresponding interface for the simulation process are shown in Fig. 3 and Fig. 4 respectively. In this process, the input parameters are taken from the user, where the user can specify and attempt various inputs, shown in Fig. 2. The output response will be displayed in time and frequency domains, and in 3D view, as shown.



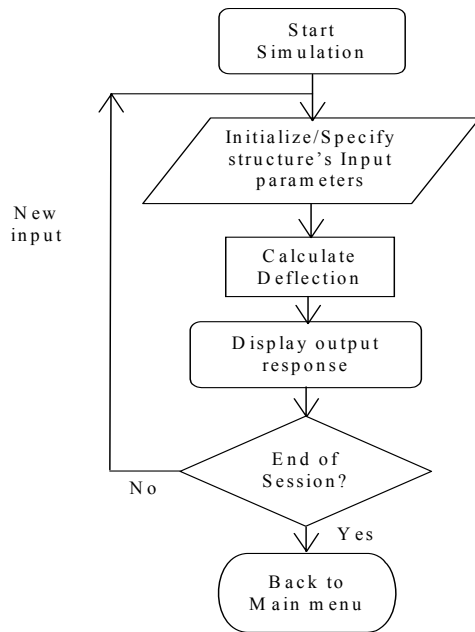


Fig. 3. Flowchart of sub-menu.

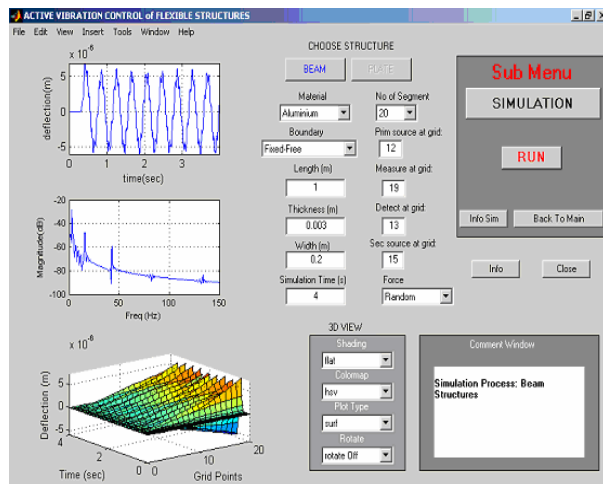


Fig. 4. Interface of sub-menu simulation for beam and plate structures.

## 2.2. Identification

A flowchart of the identification process and the corresponding interface are shown in Fig. 5 and Fig. 6 respectively. In this process, a suitable model is developed that exhibits the same input/output characteristics as the controlled process (plant). A number of techniques have been devised by researchers to determine models that best describe input-output behaviour of a system. Parametric and non-parametric identification are two major classes of system modelling techniques. Identification consists of determination of the numerical values of the structural parameters which minimize the distance between the system to be identified and its model. The parametric methods investigated in this work involve recursive least square (RLS) and genetic algorithms (GAs).

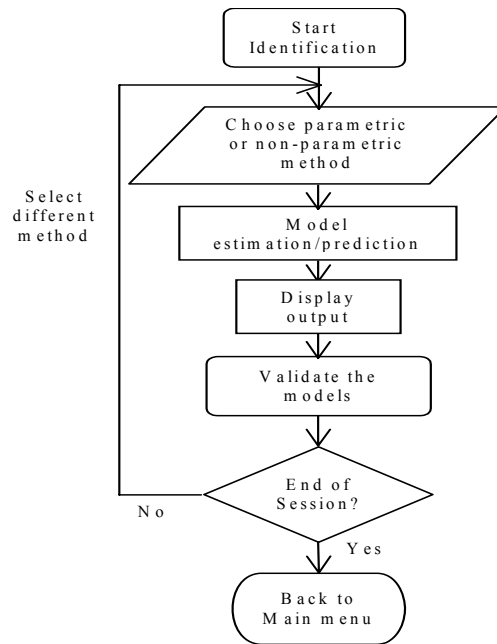


Fig. 5. Flowchart of sub-menu System Identification

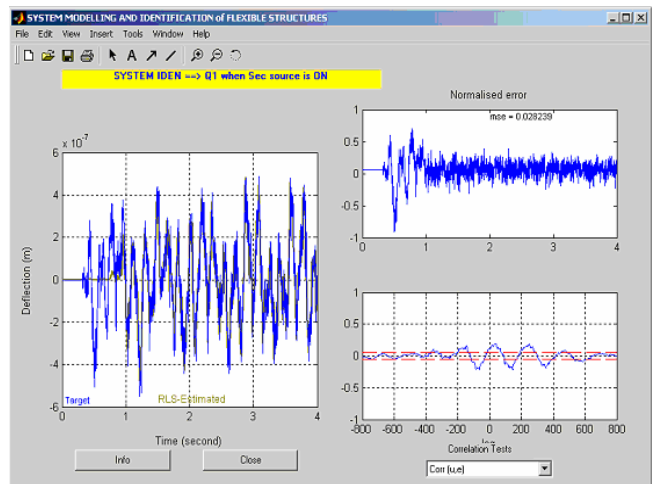


Fig. 6. Flowchart of sub-menu System Identification

On the other hand, non-parametric models utilised here are neural network (NN) and adaptive neuro-based fuzzy inference system (ANFIS) (Mohd Hashim and Tokhi, 2004a,b; Mohd Hashim *et al.*, 2004). The models obtained are validated using several techniques such as calculating mean squared error and correlation tests (Billings and Voon, 1986).

## 2.3. Control

A flowchart and corresponding interface for the control process are shown in Fig. 7 and Fig. 8 respectively. In this process, the controller transfer function is calculated based on the identified model parameters obtained in the parametric identification stage. For non-parametric approach, the controller is designed based on the networks obtained through the training process. In this sub-menu, the controller is

designed based on the method chosen in the system identification stage. The output response is displayed in time and frequency domains, and in 3D for both conditions, before and after the controller is applied.

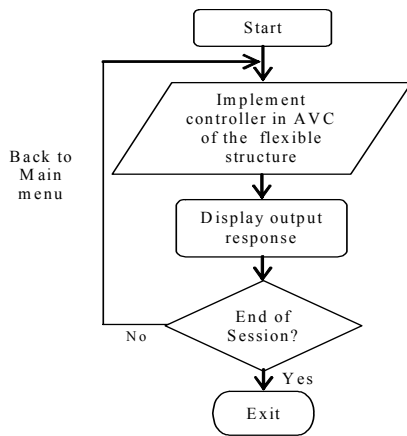


Fig. 7. Flowchart of sub-menu Control.

### 3. Conclusion

An interactive learning environment for dynamic simulation and active vibration control of flexible structures has been developed. The FD method has been used to discretise the governing partial differential equation formulation of the dynamics of the structures. The design and implementation of the interactive system incorporates three stages involved in AVC of flexible structures, namely simulation, modelling and control. Both parametric and non-parametric approaches in modelling the system have been investigated. The models obtained were further utilised for controller design. The environment thus developed forms a useful interactive and user-friendly learning and education facility in studying the dynamic features of 1D flexible beam structures as well as their control aspects.

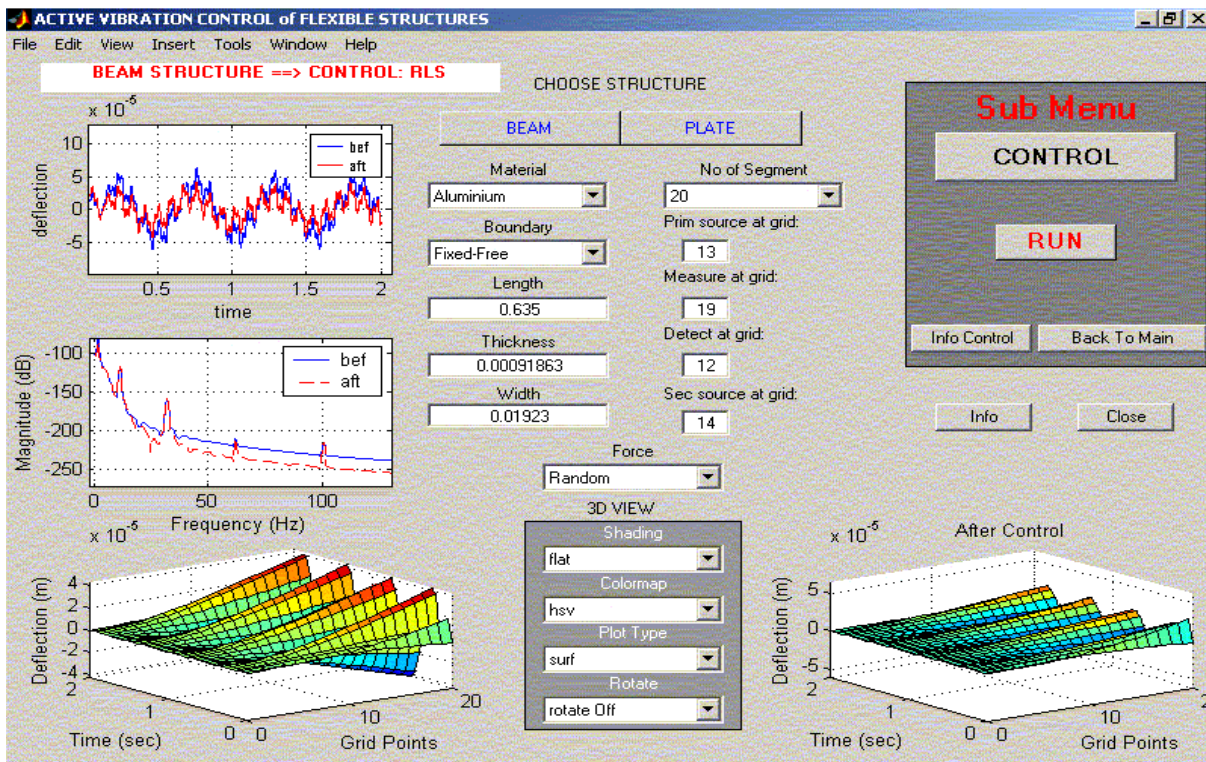


Fig. 8. Interface of sub-menu Control.

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## Desired Lecture Hall Acoustics Quality for Optimal Teaching and Learning: A Review

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### Abstract

Lecture hall is a place where teaching and learning activities takes place particularly in university and should benefit students fully. Primarily, students in university spend great amount of their time in lecture hall as lecture and tutorial are conducted in lecture hall. For an optimal teaching and learning to occur it requires conducive lecture hall environment. This can be achieved and very related to proper lecture hall acoustics design criteria. The acoustics quality that need to be thoroughly addressed and required attention during the lecture hall design stage and achieved after construction completion include Reverberation Time (RT60), Noise Criteria (NC), Sound Transmission Class (STC), Speech Transmission Index (STI), evenness of Sound Pressure Level (SPL) coverage and line eye sight. Illustration of good lecture hall acoustics quality at Electrical Engineering Faculty, Universiti Teknologi Malaysia and strategies to achieve desired lecture hall acoustics are discuss in detail in this paper.

**Keywords:** lecture hall acoustics; reverberation time (RT60); noise criteria (NC); sound transmission class (STC); speech transmission index (STI).

### 1. Introduction

To have conducive teaching and learning environment in the university, it is pertinent and important to consider from the design stage and take into account various design criteria of lecture hall acoustics. This effort should begin from the design stage as at this stage various design criteria can be properly ascertained and analyze, primarily to achieve good speech intelligibility for the lecture hall under consideration. The main aim of this paper is to highlight various acoustics design criteria that need to be taken into consideration. Specifying acoustics design criteria for future lecture hall construction should ensure lecture hall posses optimum acoustics quality and able to translate into good speech intelligibility. This situation highly beneficial and effective to the teaching and learning activity in university environment regardless of the teaching methodology adopted by the lecturers.

### 2. Related Overseas Work on Lecture Hall Acoustics

The issue of lecture hall acoustics or class room acoustics in university teaching and learning facility (II) have been investigated by other researchers in other parts of the world as in Murray Hodgson et al, 1998

[1]. This work mainly conducted at University of British Columbia, Vancouver, Canada. The study analyzed average (standard deviation) where the A weighted ventilation noise is 40.9 (3.9) dB, student-activity noise is 41.9 (4.0) dB, total background noise level is 44.4 (3.5) dB, and received speech-signal is 50.8 (3.9) dB. The average (standard deviation) A weighted speech-signal to background noise ratio was 7.9 (3.1) dB. The lecturer sound power level was 64.5 (4.2) dB. The RT60 of the classroom unoccupied at mid frequency is varied from 0.5 – 1.8 second. The lecture hall with students was varied from 6 – 254 students from seat variations of 10-291 seats. The acoustic quality of this classroom is reasonably optimum to results in good speech intelligibility.

Empirical prediction models were developed to predict ventilation noise, student activity noise, lecturer speech signal and lecturer sound power. Hodgson, 1999 [2] conducted experimental investigation of the acoustical characteristics of University of British Columbia (UBC) classrooms in Canada. The objectives of the investigations are

(I) To characterizes the 30 class rooms used in subsequent work, with respect to their main physical and acoustical characteristics.

To elucidate the main acoustical characteristics of university classroom which are relevant to classroom design and

- (III) To determine the acoustical quality of UBC classroom stock and how this depend on classroom design and the presence of students.

S.R. Bistafa and J.S. Bradley, 2000 [3] investigate extensively the effect of various Reverberation Time formula which mostly assume diffuse sound field toward RT60 prediction for a simulated classrooms. It was found out that Sabine RT60 prediction formula consistently under-predicted reverberation times. It was found out that, increased sound scattering, where diffuse sound field were created, the RT60 simulated agree well with prediction of Sabine/Eyring formula.

### 3. Lecture Hall Design Considerations

There is various acoustics quality that should be taken into consideration during the design. In particular, to ensure the lecture hall result in good speech intelligibility, even sound pressure level distribution, low ambience noise level, minimum outside noise intrusion where it is conducive and effective for teaching and learning activities.

#### 3.1. Reverberation Time (RT60)

This is the most important acoustic parameter that needs to be considered and achieved in a lecture hall. Good speech intelligibility can be achieved predominantly by having or capitalizing direct sound together with reverberant field in the region of 35 ms after direct sound. It is pertinent and important to ensure sound pressure level (SPL) of the reverberant field is lower than SPL of direct sound. Higher SPL of reverberation field after direct sound is undesirable as this could result in poor speech intelligibility. To achieve this it is pertinent to ensure lecture hall posses enough sound absorbent material inside to absorb unnecessary or unwanted excess reverberant field damaging to speech intelligibility. It is desirable to keep RT60 of occupied lecture hall in the region of (0.5 – 1.0) second at mid frequencies to ensure speech intelligibility do not suffer [4]. Low RT60 indicates the sound reverberation field is decaying appropriately. This contributes to dominant 35 ms region of direct and reverberant field where speech intelligibility can be optimized.

During the design stage, the RT60 of lecture hall can be determined as follow

$$RT60 = 0.16 V / A \quad (1.0)$$

Where:

V = Volume (m<sup>3</sup>)

A = S<sub>1</sub>α<sub>1</sub> + S<sub>2</sub>α<sub>2</sub> + ..... + S<sub>n</sub>α<sub>n</sub>

S = Surface area of the material (m<sup>2</sup>)

α = Sound absorption coefficient of material  
(0 – 1)

#### 3.2. Ambience Noise Level.

Commonly, lecture halls are normally air conditioned to provide comfort to the students. Care should be taken during the design stage and selection of air-conditioning unit to ensure low level of noise emitted from the air-conditioning system. For the lecture hall with central air-conditioning system, proper acoustics treatment along the ducting is required. Proper muffler at the air outlet should be considered to attenuate air outlet noise level. Otherwise, undesirable high noise level could be emitted and this could compromise the speech intelligibility inside the lecture hall. Further, it could create uncomfortable situation to the students and lecturer. For stand-alone air-conditioning system, proper evaluations of the noise SPL over 250 Hz to 4 kHz frequency range noise level emitted is necessary to ensure SPL emitted is acceptable. It is pertinent to target ambience noise level inside lecture hall in the region of NC 35 – NC 40 [5]. Achieving this NC level contribute to good speech intelligibility inside lecture hall. It is desirable and pertinent to ensure S/N inside lecture hall is >10 dB over all areas inside the lecture hall to optimize speech intelligibility [6].

#### 3.3. Line of Sight

For a lecture hall, which accommodate more than 60 students proper line of sight should be taken into consideration during the design stage. Otherwise, students particularly those seating in the back area would suffer as their view could be obstructed by students seating in-front areas. Further, the propagation of lecturer voice toward the back area could also be obstructed by students seating in-front area. To achieve proper line of sight, requires staircase floor seating arrangements. This seating arrangement allows students to have a clear view wherever students seated during the lecture and minimize obstruction of voice from lecturer to students seated at the back area.

#### 3.4. Reflective or Absorptive Ceiling

Good speech intelligibility can be achieved if direct sound and reverberation field is kept within the 35 ms region. In a way, if the reverberant field is being control in the 35 ms region, it can contribute to good speech intelligibility inside. This can be analyzed, through ray tracing technique. By having proper area of reflective ceiling should be able to contribute good speech intelligibility needed in lecture hall. Therefore, type of ceiling, either reflective or absorptive requires ray tracing analysis. Usually, it is not necessary to have all ceiling area absorptive or all ceiling area reflective as this might compromise speech intelligibility inside.



### 3.5. Sound Pressure Level (SPL) Coverage

It is pertinent and important to have an evenness of SPL inside the lecture hall. Properly designed lecture hall should be able to have  $\pm 3$ dB SPL throughout the listening area. Ray tracing analysis can be used to validate the need of any sound system. If needed, this can be achieved by having properly designed sound system to ensure SPL coverage and loudness are sufficient where ever the students are seating. Knowing the vertical and horizontal polar pattern of the loudspeakers under consideration, proper tilting angle can be ascertain for each loudspeaker to ensure even SPL coverage throughout the lecture hall area. This is primarily to ensure SPL variations along the seating area is  $\pm 3$  dB preferably. Small to medium size lecture hall, normally do not really need loudspeakers to reinforce lecturer voice. This natural voice reinforcement can be achieved by using reflective ceiling that should be put in proper place, proper tilting angle and with proper area to ensure the direct and reflective sound arrived to the students area within 35 ms region.

### 3.6. Sound Transmission Class (STC) of Wall Partition

The noise insulation performance for the wall and the wall partition dividing the lecture hall should not be overlooked. Proper sound transmission class (STC) is required to ensure the lecturer voice does not be heard and disturb the adjacent lecture hall in session. Further, it is also important to ensure outside noise do not invade to the lecture hall. Based on this consideration, the STC for the lecture hall should be in the region of STC 40 to STC 45 [7]. The lecture hall with wall and dividing wall with STC 40 to STC 45 will ensure minimum noise intrusion from outside and also from the adjacent lecture hall with ongoing lecture session. This STC can contribute to low ambience noise level hence this results in good speech intelligibility.

### 3.7. Speech Transmission Index (STI)

The speech intelligibility of the lecture refers to the accuracy for the students understand the spoken word or phrase. It is very important for the students to understand fully the lecture delivered. There are various method to asses speech intelligibility such as speech interference level (SIL), the articulation index (AI), the articulation loss of consonant (ALcons), rapid speech transmission index (RASTI) and speech transmission index (STI). Currently, the most widely used method to asses speech intelligibility is STI. The technique was developed in Holland during the 1970's and 1980's by two Dutch researchers by the name of Tammo Houtgast and Hermen Steneken [8]. The developed STI index acceptance level is based on Dutch language which is mono-syllable whereas Malay language is basically bi-syllable. The

STI is basically based on the reduction of the signal modulation between a source and receiver at octave center frequencies from 125 Hz to 8000 Hz. In a situation where a sound source in a room is producing noise that is intensity modulated by a low frequency sinusoidal modulation of 100% depth, the modulation at receiver position, i.e the position where the student seated, will be reduced due to room reflection and background noise. The range of STI and the rating for mono-syllable language is as in Table 1. In order to have good speech intelligibility in a lecture hall, it is pertinent to strive during the design process STI of at least 0.6 or better. However, real minimum STI value required for lecture hall in Malaysian university requires further in depth study.

Table 1. STI rating for monosyllable language

Rating	STI
Poor	< 0.4
Fair	0.4 – 0.6
Good	0.6 – 0.8
<b>Excellent</b>	<b>&gt; 0.8</b>

## 4. Lecture Hall Acoustics Case Study at Electrical Engineering Faculty, UTM.

Lecture hall P07-319 at Electrical Engineering Faculty, UTM was chosen as lecture hall that being analyze thoroughly the acoustics and speech intelligibility quality. The characteristics of the lecture hall are as shows in Table 2.

Table 1. Details of lecture hall P07-319

Description	Details
Floor dimension	<b>Length = 10.79m</b> <b>Width = 9.5m</b>
Floor area	<b>102.51m<sup>2</sup></b>
Lecturer area dimension	<b>Length = 2.59m</b> <b>Width = 9.5m</b>
Lecture hall volume	<b>265.49m<sup>3</sup></b>
<b>Student capacity</b>	<b>120 students</b>

There is a tier seating arrangements and there is no rise floor for the lecturer area in front of this lecture hall. There is also no sound reinforcement system in the lecture hall. This lecture hall is among the good lecture hall available in the Faculty of Electrical Engineering, UTM and normally being sought after by lecturers to conduct their lecture in this lecture hall. There is LCD projector available which is able to enhance the teaching technique adopted by our lecturers. The shape of this classroom is rather cubic where the front and back height is of different height due to the tier seating arrangement. Fig. 1 and Fig. 2 show some view of the lecture hall.

Acoustics quality investigation has been conducted in this lecture hall. The ambience noise



level and the RT60 are as in Table 3 and Table 4. These have been measured using Rion sound level meter Octave Band Analyzer Type NA 29. The microphone used was UC – 53 and the measurements are in conformance to IEC-651 – type 3. Calibration was done prior to the measurements. 9 measurement positions were used, where 3 each in front, middle and back area. The ambience noise level has been measured at octave band centre frequencies at 125Hz, 250 Hz, 500Hz, 1 kHz, 2kHz and 4 kHz. The main source of the ambience noise inside this lecture hall is due to the air-conditioning system available in this lecture hall. Based on the measured ambience noise SPL as in Table 3, it is evident that the ambience noise quality is reasonably within the accepted range. This is considering that the Noise Criteria is **NC 35**. The measured ambience noise SPL were based on average value of two measurements over the 9 measurements position mentioned above.

The RT60 of this lecture hall were measured at 250 Hz, 500 Hz, 1 kHz, 2 kHz and 4 kHz. The empty RT60 is as in Table 4. The RT60 calculated with 2/3 of students capacity is as in Table 5. Considering the RT60 value as in Table 4, RT60 empty suggest that the RT60 value is not optimum or suitable to results in good speech intelligibility. However, Table 5, RT60 with 2/3 students capacity suggest that the RT60 has improved and this able to results in good speech intelligibility during lecture. It is pertinent to have RT60 during the lecture that able to results in good speech intelligibility which is required for effective lecture to benefit the students.



Fig. 1. Front view of lecture hall.



Fig. 2. Staircase floor seating arrangement.

Table 2. Lecture hall ambience noise level

(Hz)	A	B	C	D	E	F	G	H	I	Ave (dB)
125	44.35	40.4	38.45	39.25	38.25	41.3	44.45	37.75	39.4	40.4
250	38.85	38.05	38.8	34.0	37.8	33.3	41.0	34.1	37.1	37.67
500	42.8	41.7	38.9	40.1	40.5	40.35	39.0	40.7	38.25	40.3
1K	34.5	34.35	33.7	33.45	32.7	34.9	33.7	34.1	32.3	34.2
2K	31.75	31.2	29.7	29.25	27.45	29.85	29.45	29.7	28.8	28.7
4K	27.9	27.9	24.35	25.9	24.95	24.85	27.35	24.35	24.35	24.5

Table 3. RT60 Empty Lecture Hall

Frequency (Hz)	250	500	1K	2K	4K
RT60 (second)	1.4	1.5	1.7	1.6	1.7

Table 4. RT60 with 2/3 students

Frequency (Hz)	250	500	1K	2K	4K
RT60 (Second)	0.74	0.74	0.75	0.73	0.78

Considering the RT60 data as in Table 5 suggest that the RT60 with 2/3 students is reasonably close to the optimum RT60 value which is in the region of 0.7 sec. This suggest that, during the lecture, predicted RT60 with 2/3 students should be able to results in good speech intelligibility.

## 5. Conclusions

Good acoustics quality of lecture hall contribute significantly to the effective teaching and learning process as students should be able to understand the delivered lecture rather easily. The acoustics qualities that need to be taken into consideration are as discuss earlier. The discuss design criteria are basically based on established Western population acceptance. Therefore, it is timely and pertinent for the country to have our own design criteria to guide the authorities. However, in the mean while, until the country have our own lecture hall acoustics design criteria, established Western acoustics design criteria should be used as a guide to achieved desired acoustics quality for the lecture hall. It requires effort from various parties primarily the architect and acoustics consultant. Understanding on various acoustics design criteria, proper specification during the design stage and right implementation during the construction are necessary. These are prerequisite to have lecture hall with good acoustics quality optimal for effective teaching and learning in university environment.

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## UMT's Technological Programs and Education Technology

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### Abstract

It is imperative that Malaysian institutions of higher learning respond to the changing market demand by having relevant technical curriculum and training. This paper provides an overview of the importance of maritime and environmental sectors to the Malaysian economy and well being. The concept of the Bachelor of Applied Science (Maritime Technology) and Bachelor of Technology (Environmental Technology) will be outlined. The facilities required to run the programs will be briefly described. Teaching and E-learning education especially to maritime program is presented.

**Keywords:** human resource; e-learning; maritime technology; environmental technology

### 1. Introduction

#### 1.1. History of UMT and FMSM

Universiti Malaysia Terengganu (UMT) started as fishery training center for Universiti Pertanian Malaysia. Later it was known as Universiti Putra Malaysia Terengganu (UPMT). In 2000 the university branch was upgraded to Kolej Universiti Terengganu. Later it was further upgraded to Kolej Universiti Sains dan Teknologi Malaysia (KUSTEM) in 2002. On 1st February 2007, the university was rebranded to Universiti Malaysia Terengganu.

Presently, UMT has four faculties and three institutes. The university offers various courses and services. The university offers courses at diploma, degree, masters and PhD level. Higher education ministry has identified UMT to focus in maritime and related programs.

The largest faculty in UMT is Faculty of Science and Technology. The newest faculty is the Faculty of Maritime Studies and Marine Science (FMSM). There are three departments in the FMSM faculty namely, Department of Maritime Management, Department of Marine Science, and Department of Marine Technology (JTM).

#### 1.2. The importance of maritime programs

Malaysia is the 17<sup>th</sup> largest trading nation in the world. Shipping has particular importance to the economic development of Malaysia. The volume of exported and imported goods through the sea transportation amounted to 95% of the total trading [1]. Due to the geographical location,

Malaysia is dependent on shipping for import and export, thus changes in shipping patterns, international regulations/requirements, rates and tariffs will have major on Malaysia economy. Hence there is an increasing demand for the maritime manpower including for shipping, port management, transportation linkages and the related activities. The industry requires skill manpower and expertise to boost up the development of this sector.

In meeting the abovementioned needs a special study was conducted to uncover the possibility of developing tailored program, which tackles the main issues in the maritime industry. The finding [1] shows that there appears to be a gap in the higher learning centers in providing courses that meet today's demand. A total of top 40 companies involved directly in the field of logistics, transportation and maritime agencies were being interviewed in solving this dilemma. The output was ecstatic. 79% of the respondent acknowledges the need to establish a degree program in Maritime Technology and Nautical Science studies. An almost 90% agreed that there is definitely most timely that such program were needed in this declining stage of the employment of human resources in the maritime industry. In another study done by the Asians Port and Logistics directory 2005 [2], a total of 862 companies urgently require professionals and semi-professionals to fill various job descriptions. In another study done by Petronas Training and Education [3-4] has come up with an idea towards tackling the needs of the Malaysian Maritime development agenda known as the Maritime Education and Training Master Plan (METMP). The study showed 6 areas of education development in order to mature in the International maritime industry. Amongst those areas are; Design,

Manufacture, and Construction, Shipping and Water borne Operations, Offshore Energies, Living Resources, Supporting Services and Other Marine Resources.

The design includes boat, shipbuilding, design and repair. The manufacturing includes maritime equipment and instrument. The construction includes the fabrication of offshore structure. The shipping and water borne operations includes freight and passenger transportation and terminal and port operations. The offshore energies comprise of ocean energy, petroleum and gas.

### *1.3. The importance of environmental programs*

In-line with the Malaysia's needs in safeguarding of the environmental as one of the ten principles of *Islam Hadhari* that was introduced in 2004, the Bachelor Degree of Environmental Technology program that was offered from year 2000 in the Engineering Science Department under the Faculty of Science and Technology (FST), Universiti Malaysia Terengganu (UMT) had long ago (4 years back) foresee the importance of such program. This program contained the aspects of environmental sciences (soft sciences) and environmental engineering (hard sciences). Dating back to the year 2000 before the Ninth Malaysia Plan, the will of Malaysian government of achieving a competitive and advance nation through our ultimate Vision 2020, our nation requires workforces to fulfill a wide range of fields. In this regard, Department of Engineering Science as one of the many departments in FST, UMT had foreseen the importance and subsequently took up this opportunity to generate sufficient human resources for rapid expanding industries. There are few main career pathways best suit for the graduated students, such as, officer/manager/member of technology in fields of: (i) solids and hazardous wastes; (ii) air quality; and (iii) water and wastewater treatment. In addition to that, they could be employed as an officer of environmental impact assessment consultant, environmental researcher or even as an educator either as lecturer or schoolteacher regarding to environment.

## **2. Maritime and environmental technological programs**

### *2.1. Maritime programs*

Malaysia has a very long coastline and surrounded by water. As such Malaysia is indeed a maritime country. Jobs related to offshore oil and gas, fishery deep sea exploration, commercial shipping, exclusive economic zone (EEZ) management, coastal and ocean mapping, maritime defense and enforcement, etc are some of the job

opportunities required in local maritime industry [5-6].

There are five programs offered at the undergraduate level in UMT. The courses offered at the undergraduate level are as follows: Bachelor of Maritime Management, Bachelor of Science (Marine Biology), Bachelor of Science (Marine Science), Bachelor of Applied Science (Maritime Technology) and Bachelor of Science (Nautical Science and Maritime Transport).

In UMT Bachelor of Maritime Management, Bachelor of Science (Marine Biology) and Bachelor of Science (Marine Science) are three-year programs while of Bachelor of Applied Science (Marine Technology) and Bachelor of Science (Nautical Studies and Maritime Transport) is a four-year program. There are some subjects, which are common to all programs. Students taking the above programs have to undergo ten to twelve weeks of industrial training in various organizations and industries during long vacation. Additionally, the curriculum needs to incorporate training and exposure to maritime safety.

As for the Maritime Technology specialization subjects to be taken, they were carefully selected so as to ensure that the graduates would be able to perform the functions to be carried out by an experienced worker to a certain extend. Among the career path for a maritime technologist are ship-servicing companies, ship building companies, ship operators, public maritime agencies, oil and gas exploration companies or shipping equipment supplier.

Beside UMT, UTM, MIMET, PUO and ALAM are offering maritime related academic programs. UTM is the pioneer in Marine Engineering specializing in Naval Architecture. In 1996 UTM acquired comprehensive Marine Technology laboratory, which cost 30 million Malaysian ringgit. PUO and ALAM offers diploma in marine engineering while the latter has additional program in seafarer program, while MIMET two diploma programs in Ship Construction and Maintenance and Ship Design [7].

#### *2.1.1. Maritime technology at JTM*

This program is designed to train students in the following career path: ship and port technology, resource exploitation technology, marine instrumentation, offshore structures and naval architecture. Example of subjects planned to be offered to the students include marine corrosion, marine hydrodynamics, offshore structure, marine cooling and refrigeration system, diesel engine, marine salvage, ocean management, maritime communication, geological oceanography and marine pollution.

### 2.1.2. Nautical study at JTM

This program is designed to train students in the following career path: aboard ships, port operators, shipping business, including merchant shipping, port, port traffic controller, ship brokers, marine insurance, port naval officer, consultant and other related fields. The duration of study is a 4 years degree with options for certificate of competency 1 year. Plus one year of sea time in compliance with STCW and Malaysian Marine Department's requirements. In obtaining certifications, the Malaysian Marine Department shall oversee the examinations requirement. Other co-operations with Malaysian shipping firms will be forwarded to ease the process in obtaining sea-time requirements. At the same time UMT will be working closely with ALAM to complete and complement each other to make this program successful.

### 2.2. Environmental program

The courses of the program can be divided into three main components that are university core courses (20 credit hours), program core courses (89 credit hours) and elective courses (15 credit hours). Students are allowed to choose elective courses either from the stream of water and wastewater, or from the stream of air, solids and hazardous wastes. Apart from this, students will have to undergo industrial training, which takes 6 credit hours as part of program core courses for the period of 10 weeks during semester break between the sixth and seventh semesters. In realizing the needs of educational facilities as an important element in generating qualities graduates, The Universiti Malaysia Terengganu has its Sultanah Nur Zahirah Library's capacity in supporting educational system that capable of supplying overwhelm reading materials for teaching and research needs.

## 3. Facilities required to support the program

### 3.1. Facilities for maritime programs

It can be seen from the previous section that the curriculum proposed by program consultants resulted in large amount of time placed on practical training or laboratory work. New facilities particularly relating to Maritime Technology need to be acquired. In this respect, the machine workshop lab, engine and power plant lab, general technology lab, marine electronic and instrumentation lab and naval architecture and drafting lab are being set up. Among the equipment to be placed in the laboratories as PC and Workstation Software System which are including Computer Aided Design and Drafting (CDD) for Inventor Series Professional and Ship constructor), Computer Aided Design (CAD) and Computational Fluid Dynamics (CFD) for Maxsurf and An Integrated Shipyard Resource Planning

Management System for PERCEPTION. Other equipment is Computer Base Training (CBT) and Data Acquisition System (DAS) that are including AC and DC Technology Experimental Kit and Electronics and Instrumentation Experimental Kit. Beside that, others to be placed in the laboratories are Engine Speed Control apparatus, The Electronic Navigation Simulator Laboratory, GMDSS (Global Maritime Distress and Safety System) simulator and Bridge Simulator.

In addition to the above laboratories, other laboratories such as the Machine Shop as well as other Mechanical Engineering laboratories are also available for teaching as well as research purposes.

### 3.2. Facilities for environmental program

In providing adequate practical exposure and training purposes for students on the practical side of theories, laboratory facilities were strengthened with the latest instruments that fit the purposes of the required program core courses, from the laboratories of thermodynamic, fluid mechanics to the material science, electronic and instrumentation and environmental technology which are included the UV-Spectrophotometer, Metallurgical Microscope, Streaming Potential Meter, Portable Gas Detector, NOMAD Weather Station, Universal Testing Machine, HVAS, Metallographic equipments, Autotitrator, Autoclave and others.

In addition to the above facilities, the Engineering Science Department has also introduced the Renewable Energy including wind, solar, and hydrogen energy system and Membrane Technology for elective subjects as well as research purposes as part of the Environmental Technology Programme for ensuring the students are exposed to the current environmental technology [8].

## 4. Teaching and learning approaches

### 4.1. Adult learning approaches

Besides using pedagogy approaches (art of teaching), lecturers and demonstrators implant Andragogy (adult learning) approaches in teaching and leaning activities.

Malcom Knowles identified that adults are relevancy oriented, practical in determine their direction of learning. Knowing some of their preferable, our university consider the following teaching and learning approaches:

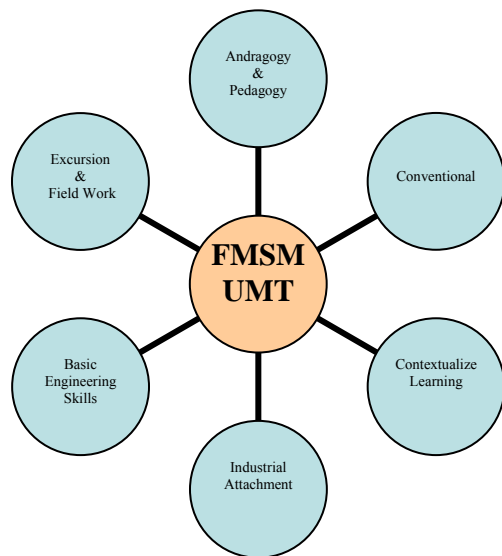
- Adults are **relevancy-oriented**. Teaching and learning approaches activities must have correlation between theories, concept, and practical.
- Adults are **practical**. Lecturers must tell students explicitly how the lesson will be useful for them on the job.

#### 4.2. Contextualize learning approaches

Now world is rapid changing due to globalization and learning technique is being revolutionized where industry requires a workforce that is more self-sufficient and autonomous. University must always think ahead to produce student with contextualize learning approach that introduce students to real application in real work condition instead using conventional techniques. The demand from industry and cut-off budget from stake holder will make university difficult to fulfill the requirements. Base on that factor CBT is more reliable to use as a tools for teaching and learning.

Leading to that, UMT is actively using CBT technique, which is reliable and efficient when theory and practice merged into one software and hardware package for teaching and learning processes.

The curriculum also embedded with some basic engineering hand-on skills such as machining, welding and fabrication for them to know, feel shop floor job specification.



**Fig. 1:** Teaching and Learning Approaches in FMSM

Excursion and field work (Fig. 1) is arranged to industry or venue in Malaysia for student to grasp working environment, application, visualization, real application in industry and students also is compulsory for industrial attachment at final year program.

Curriculum development committee's consists of Industry Experts, Professional Academia that serve several of maritime areas in their teaching and vast experience.

#### 4.3. Lifelong and E-Learning in Maritime Education

There is a distinct difference between General Education and Maritime Education. The former is a matter of acquisition of knowledge and the latter has furtherance with the capacity to apply acquired knowledge into workplace. Thus the Maritime Education does give its complete sense with an

additional world of 'Lifelong Training'. Spontaneously, all the maritime learners are students of distance and lifelong learning. Living months at sea preparing for competency examination keep them busy at their workplace as well as on the cabin-desks. Needless to mention that the time for preparatory courses alone cannot fulfill the desired readiness for competency training. On the other hand, in way from Cadet to Captain or Chief Engineer a mariner continuously remains at full-time learner.

Simulator manufacturers are coming up with newer practical scenario based tasks/courses that directly help the learners at sea. General situation can easily be matched with his/her ships practical ones. Simulations at desktop and in the internet make learning a very timely one. Latest or upgraded courseware is always available at the sites. Moreover, on-board and on-shore courses are combined through the web-based learning method.

### 5. Job opportunities

#### 5.1. Maritime job opportunities

The local and regional ship repair and conversion industry has made a remarkable progress within the last decades in Malaysia in specific and in the world in general. This is the indicator [5] that the maritime sector is an important contributor not only to the well being of our economy but also to the development of world economy, with the government making great efforts in developing the industry and establishing the country as a maritime center to the region. One of the main components of the effort is the creation of a pool of technological competent maritime staff. Employees are the greatest assets and we have to have very technical and skilled workforce. In general, there has been a growing shortage of competent officers and engineers but a heavy and expanding demand. Malaysia Marine and Heavy Engineering Sdn Bhd, for example, their employee capita is among the highest in the region at RM0.401 million/employee against the regional average of RM0.285 million/employee [5].

#### 5.2. Environmental job opportunities

This program has been offered over the last 7 years, and is currently celebrating its success in generating graduate students that are successfully working in the fields of environmental engineering, process engineer, project engineer, consultant, DOE's officer, sales in environmental related products, etc. Within their four years of education, students are not only expected to have the abilities in both environmental science and engineering courses, they are expected to be skillfully applying or at least be able to identify suitable methods and tools in solving contemporary environmental problems, which eventually contributes towards the overall

success of nation's sustainable development plan. In this regard, they should be competence in joining the workforce market as [9]: (i) Officer or manager or member of technology in solids and hazardous wastes in *Dewan Bandar Raya*, Municipal Council and local councils including Department of Environment and Indah Water Consortium, IWK. (ii) Officer or manager or member of technology in air quality in agencies and certain factories, which related to environment. (iii) Officer or manager or member of technology in water and wastewater treatment in Water Supply Department or states water board, Department of Sewerage, local council, IWK, Department of Environment and private agencies that involved in handling of water and wastewater. (iv) Consultant of environmental impact assessment and researcher in governmental agencies or private environmental related fields.

## 6. Conclusion

We have noted the importance of maritime industry to the Malaysian economy and the crucial aspect of marine related education curriculum in order Malaysia can fully utilize the ocean resolution. If the Malaysian economy wishes to stay ahead of its competitors, the maritime sector serves as a valuable resource that would improve the national's standings.

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## Flow Visualisation in Prandtl Channel - Project Based Learning in Fluid Mechanics

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### Abstract

Engineering Design modules, usually introduced in the first and second year's undergraduate Mechanical Engineering courses, present a unique platform to practice the Project Based Learning (PBL). PBL is a widely accepted technique that can be used to achieve two major educational goals; affirming the theoretical principles studied in other modules and developing the professional skill essential for graduates such as team working and effective communication skills. In this paper we describe the use of PBL to enhance the understanding of turbulence, a classical problem in fluid mechanics. The project is carried out in the "Mechanical Engineering Design & Professional Skills" Module, which requires the students to construct the Prandtl recirculating water channel. The skills and knowledge involved not only fluid mechanics, but design, material selections and engineering mechanics, making it a truly multi-disciplinary project.

**Keywords:** engineering education; flow visualisation; fluid mechanics; learning outcomes; project based learning

### 1. Introduction

Engineering is a profession that has continuously re-invented itself to respond to the ever changing economical and social needs. This dynamic nature is mirrored in engineering education as well where the latest learning and teaching theories are practiced. One of the most successful approaches to learn engineering is the problem (or project)-based-learning (PBL) whereby the problem is the starting point of the learning process. Problem-based-learning was introduced almost twenty years ago in health sciences as a way to prepare students to handle ill defined, multi-disciplinary problems such as medical diagnosis [1]. Soon, mainly due to students' enthusiasm for this new approach it was introduced in other disciplines and, among others, in undergraduate design courses in engineering [2], [3]. This often resulted in deeper understanding of the explored topics [4]. As during the nineties emphasis shifted from taught to learned in the accreditation criteria, more and more design projects were included in engineering curricula, even in the first year of study [5], [6]. In engineering context, this approach is also known as project-based-learning. The inclusion of a set of different projects, allowing the student to become acquainted with the specifics of different engineering disciplines before having to choose one, is believed to be an original idea.

Although it is preferable for these problems (or projects) to be real life ones, hypothetical problems

(projects) may have their own merits. It is crucial that the problem serves as the basis for the learning process, because this determines the direction of the learning process and places emphasis on the formulation of a question rather than on the answer. This also allows the learning content to be related to the context, which promotes student motivation and comprehension. It is essential that the directing force is consistent with the way the assessment drives the educational method [7].

In this paper we present the use of a project that involves the use of flow visualisation with the learning outcome of an understanding of the nature of turbulent flow structures. This is achieved within the "Mechanical Engineering Design & Professional Skills" module offered at the First Year (two semesters) mechanical engineering course.

Flow visualisation projects were widely used as a teaching and learning tool in undergraduate and postgraduate courses, e.g. Hertzberg and Sweetman [8]. They offered a Flow Visualisation Module to the Masters students from the engineering and the art streams. In this module students were required to design their own projects to yield flow visualisation images of good quality. A sample of their students' work is shown in Fig. 1.





Fig. 1. Buoyancy through interface. A buoyant jet of dyed 70% isopropyl alcohol rises through the interface formed by corn syrup and water. [9]

## 2. Module description

The “Mechanical Engineering Design & Professional Skills” carries 20 credit hours out of the total 120 credit hours required by the students to complete their first year of the course. The learning outcomes of this module are shown in Table 1.

Table 1. Learning outcomes of the design module

1. Describe the design process, including the concept of design constraints and the iterative nature of design.
2. Demonstrate awareness of design in other disciplines.
3. Recognise the values of effective team-working.
4. Contribute effectively to team based written project report.
5. Use appropriate visual communication techniques to communicate concepts and ideas.
6. Demonstrate awareness of industrial design.
7. Design a simple mechanical device to meet a specified need involving the understanding of basic mechanical engineering principles.
8. Carry out initial research on a real-world design task and present it effectively.
9. Demonstrate a working knowledge of the patent system and intellectual property rights in general.

This module is assessed through a series of reports, presentations and other course work activities that draws on working in a team to design, build and test a mechanical artifact.

## 3. Project selection

In the current context a team of 5 students are given the task to build a replica of Prandtl’s circulating water channel shown in Fig. 2 and use this channel to perform flow visualisation studies to understand the flow structures downstream of square cylinders. The project hand-out is shown in Fig. 3.

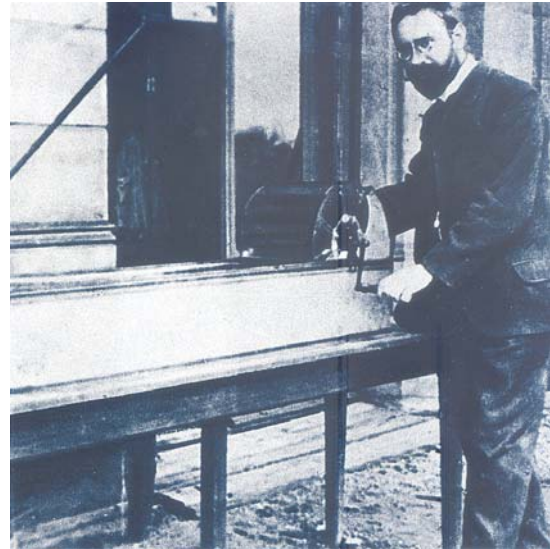


Fig. 2. Prandtl and his water channel.

### Mechanical Engineering Design & Professional Skills

#### Prandtl Channel Project

Prandtl is considered one of the forefathers of modern fluid mechanics. He achieved a number of his discoveries using flow visualisation in a simple water channel. Your task would be to build a replica of that channel and use it to visualise the flow in the wake of square cylinders.

#### Objectives

1. Assess the design of the original Prandtl channel.
2. Suggest improvement to the design.
3. Construct the (improved) channel.
4. Test and calibrate the channel
5. Build models of square cylinders to be tested in the channel.
6. Use flow visualisation technique(s) to assess the flow structures in the wake of the cylinders.

#### Time Allocated

Tunnel design, construction and calibration: Semester 1  
 Flow Visualisation: Semester 2

#### Assessment

Operational Model:	50% (Group Effort)
Report:	30% (Individual Effort)
Presentation:	10% (Individual Effort)
Logbook:	10% (Individual Effort)

Fig. 3. Handout of the Prandtl channel project.

The Prandtl water channel is a recirculating channel in which water is circulated using a wheel that is operated manually. A cross-sectional sketch of the channel is shown in Fig. 4.

This project was selected for various reasons. It can be carried out within the available resources and timeframe, it has a history element attached to it that inspired the authors in the first place and it was hoped to inspire the students as well, and that it leads to a flow visualisation images which are hoped to kindle the interest of students in Fluid Mechanics which is a subject often perceived by students as difficult to imagine as they are unable to visualise it in action.

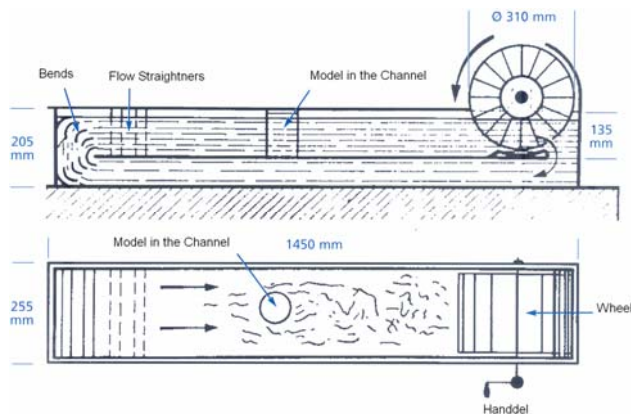


Fig. 4. Schematic view of Prandtl water channel.

The Karman vortex street behind a cylinder has been the object of numerous experimental and numerical studies because of the fundamental mechanisms that this flow exhibits and its numerous industrial applications. The classical view of a vortex street in cross section (2D) consists of regions of concentrated vorticity shed into the downstream flow from alternate sides of the body (and with alternate sense of rotation), giving the appearance of an upper row of negative vortices and lower row of positive vortices. This alternate shedding of vortices in the near wake leads to large fluctuating pressure forces in a direction transverse to the flow and may cause structural vibrations, acoustic noise or resonance. The formation of a vortex street is generally considered to be the result of a coupling of Kelvin–Helmholtz instabilities with separated shear layers. In each shear layer, the instabilities lead to vortex-sheet roll-up [10].

## 4. Results and discussion

### 4.1. Channel design

Initial assessment of the design of the original channel was undertaken in order to suggest some improvements to the design. The main

improvements suggested were to use transparent acrylic sheets (8 mm in thicknesses) to build the channel rather than the metal sheet used in the original and to use an electric motor to run the channel rather than the manual drive.

These improvements would allow for better visual access to the model and a better control of the lighting conditions and angles to achieve better flow visualisation. Using a DC motor drive instead of the manual drive for the channel wheel would result in a better control for the flow and yield more consistent results. The motor used was an automobile (Proton- Wira) power window motor. The modified channel is shown in Fig. 5.

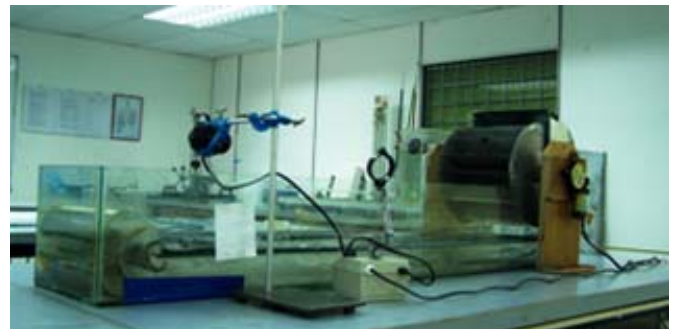


Fig. 5. The modified channel.

### 4.2. Flow visualisation

The flow visualisation was realised by seeding the circulating water with silver glitter dust that is used in cosmetic industry. The glitter dust is selected because it is easily available, floats in water and the fact that it has superior optical qualities that allows for good flow visualisation images when coupled with a right lighting conditions and camera set-up. A sample of the results obtained by the students is shown in Fig. 6.

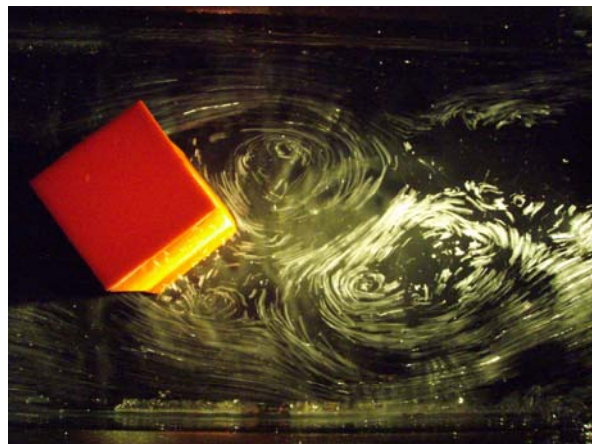


Fig. 6. Flow visualisation across a square cylinder at Reynolds number of 6800. The flow is from left to right.

It is clear from Fig. 6 that there is shedding of counter-rotating vortices behind the cylinder.

#### 4.3. Learning outcomes

The learning outcomes of the module were achieved. Although the project is Fluid Mechanics related, the construction of the channel invoked materials and engineering mechanics knowledge as well.

Besides gaining better understanding of fluid mechanics, the students exhibited a great deal of enthusiasm and ownership in the course of constructing and testing the channel. Little was needed from the lecturer to keep them motivated.

### 5. Conclusions

Building a replica of the Prandtl recirculating water channel and using it to create classical flow visualisation images was used as a design project offered in the "Mechanical Engineering Design and Professional Skills". Through careful selection of the project and the assessment criteria, the learning outcomes of the module were achieved. Better knowledge and understanding of fluid turbulence, Reynolds number and the characteristic length of a given problem were achieved in the process. Students' enthusiasm and motivation were apparent throughout the course.

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## An Examination of Electrical Engineering Course Learning Outcomes using Rasch Measurement Model: A Performance Evaluation

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### Abstract

The Faculty of Electrical Engineering (FKE), Universiti Teknologi Malaysia teaching and learning processes were duly certified to ISO 9001:2000. One of the top management commitments is to meet the Engineering Accreditation Council of Malaysia (EAC) program accreditation requirements. EAC adopts the American Accreditation Board of Engineering and Technology 2000 (ABET) principles which promote outcome based education (OBE) learning process. OBE calls for the evaluation of the course learning outcomes (LO) as specified in each Course Outline. Performance measurement has been largely dependent on students' performance in carrying out tasks such as tests, quizzes or submission of assignments. Evaluation on the performance outputs; categorized as technical knowledge and generic skills, gives an indication on the achievement of the course expected LO. This paper describes a computational model which can be used to measure a course LO of an undergraduate electrical engineering programme. An overview of the measurement model and its key concepts are presented. ESPEGS Model is the acronym for Engineering Student Performance Evaluation on Generic Skills. This model can be used to improve the students' assessment method and validate the LO of each course. Results obtained were assessed against the course LO Maps for consistency and used as a guide for future improvement of the teaching method and style. The study shows that this model of measurement, which adopts the Rasch -Uekawa Logistic Regression Model, can classify students ability accurately based on the course LO with only very few randomly selected students and dimensions.

**Keywords:** learning outcomes; test evaluation; performance measurement, quality; continuous improvement

### 1. Introduction

Factors such as increased global competition, accelerated technological advancements and enhanced customer requirements have caused fundamental changes in the manner in which organizations compete. Organizations can no longer compete solely on the basis of cost: *value-for-money* but must formulate competitive strategies defined by industrial market-driven requirements. Therefore, it has become increasingly important for organisations to develop strategic objectives which facilitate the development of a competitive advantage in specific markets or market segments. Strategic objectives are initiatives designed to have a significant and favorable effect on the long-term health of the

organisations; in this case the Institution of Higher Learning (IHL) to remain relevant and sustainable.

The improvement of products or programmes offered, processes for teaching and learning, and service quality have been adopted by many IHL as the key strategic objectives for achieving world-class performance levels [1]. However, sustainable world-class performance will not occur if there is a misalignment between an IHL's programme objectives and actual market requirements. In addition, effective faculty wide coordination in relation to market driven initiatives is essential for ensuring the effective use of IHL's resources.

In order for an IHL to successfully compete on its strategic programmes objectives, relationships must exist between the IHL's strategies, faculty wide actions and performance measures. Not only are



specific action programs supporting strategic objectives required, but also integrated performance measurement systems which facilitate consistent organizational actions towards achievement of objectives. Performance Measurement Systems (PMS) are composed of three elements: performance criteria, performance measures, and performance standards [2]:

1. **Performance criteria** are the relative elements used to evaluate performance.
2. **Performance measures** are the actual values of performance criteria over some specified time period; and
3. **Performance standards** are the accepted levels of performance for each criteria.

In an IHL, PMS provides means for:

1. maintaining an **alignment** between strategic programme objectives and industry requirements;
2. coordinating the **effective** use of IHL resources; and
3. **monitoring** the progress of teaching and learning towards the achievement of pre-determined learning outcomes (LO); hence, the LO Map.

Thus, a PMS is required for each LO to serve as a mechanism for monitoring progress, hence, achievement of objectives.

The purpose of this paper is to provide a normative model for the development of quality focussed engineering education PMS. The model is developed based on a longitudinal evaluation of selected electrical engineering student's performance since academic session Sem.1 2003/04 until Sem.1 2006/07 in the Faculty of Electrical Engineering, University Teknologi Malaysia, Skudai, Johor. The study focused on the relationship between a teaching and learning (T&L) method and students PMS designed to support FKE Programme Objectives (PO) so as to facilitate faculty wide coordination to continually improve the quality of engineering education.

FKE needs to comply to the Engineering Accreditation Council of Malaysia (EAC) programme accreditation requirements. EAC adopted the American Accreditation Board of Engineering and Technology, 2000 (ABET) principles which promote outcome based education (OBE) learning process. OBE calls for the evaluation of the course LO's as specified in each Course Outlines. In FKE, Performance Measurement has been largely dependent on students' performances in carrying out tasks such as tests, quizzes or project papers/ assignments. Evaluation on the performance outputs; broadly categorized as technical knowledge and generic skills, gives an indication on the achievement of the course expected LO's.

Monitoring and measurement is a vital process, meeting the PDCA approach – *Plan, Do, Check Act*; the founding method of ISO9001:2000 to assure

customer satisfaction where FKE teaching and learning process is duly certified. The resulting model provides a foundation for further development of quality-focused engineering education performance measurement system theory based on empirical findings. In addition, the model can be used as a framework as an instrument for the implementation of quality-focused performance measurement systems in IHLs.

## 2. Background: An overview of performance measurement

Performance measurement of LO in IHL is relatively new, undeveloped and yet to be studied systematically. Although some of the functionally-based performance measurement literature examined performance relationships across functional areas, little was written about the alignment of functional performance to overall programme outcomes. Moreover, many of these articles focused on the local optimization of each area of study on a stand alone basis with little regard for how other teaching and learning dimensions or attributes may be affected. This situation calls for the adoption of a more global engineering education performance measurement mechanism which would optimize the effectiveness of teaching and learning thus benefits the entire programme.

The authors conducted a comprehensive review of literature pertaining to performance measurement system design and categorized it into three distinct areas [1, 3]:

1. individual performance measures;
2. performance measurement systems as an entity; and
3. relationships between performance measurement systems and the environment in which they operate.

Early researchers who focused on individual performance measures examined various dimensions of quality education, cost, time, and flexibility from a strategic perspective. In an attempt to define the various attributes of a performance measurement system, researchers developed frameworks for relating functional or teaching and learning performance to overall programme performance.

Recent developments examined the interaction between a performance measurement system and the teaching and learning methods. Literature pertaining specifically to quality-focused performance measurement systems can be classified into three (3) broad categories:

1. quality measures;
2. quality measurement; and
3. frameworks for developing quality measurement systems.

The use of statistically-based measures to monitor and control process and product quality was

pioneered by Shewhart in 1931, Juran in 1951 and subsequently Deming in 1975 from which Kane in 1986 explored the use of capability indices as a measure of process quality [3]. An attempt to measure the Learning Capability Index by the authors was presented in the International Forum on Engineering Education (IFEE 2006), Sharjah, UAE [4]. It provided some insight on the development for a more comprehensive evaluation system and assessment of the strategic impact of an engineering education quality initiative.

It is good to note other researches done in PMS which addressed the problems associated with the use of quality measures in isolation and highlighted the need for a holistic approach to quality performance measurement. In the advent of internet and globalisation, it was asserted that information systems are also an essential dimension for an excellent framework of a quality management system.

Performance measurement should generate accurate, meaningful information i.e., be reliable and valid. Performance measurement represents a vision that can shape the future direction of classroom-based assessment; hence course LOs, but it requires much additional scrutiny and development before it can fulfill its promise.

There is a need to articulate the need for IHLs to adopt a “customer-driven” approach to quality engineering education designed to avoid misalignments between an IHL product; the programmes offered, or service offerings; teaching and learning; and the requirements of the targeted industry market segment. A good PMS can enhance the understanding of such alignment, and assist academicians in developing as well as maintaining quality and relevant engineering programmes duly aligned between IHL and the industry.

Performance Measurement can be summarily viewed in the correlational ABC Model in Figure 1 on how cognitive skills and affective state is reflected in the behaviour of students during learning. Weybrew discussed at length on the repercussion of such development but believed that affective values is of significant importance in neuro-linguistic programming otherwise popularly known as NLP [5].

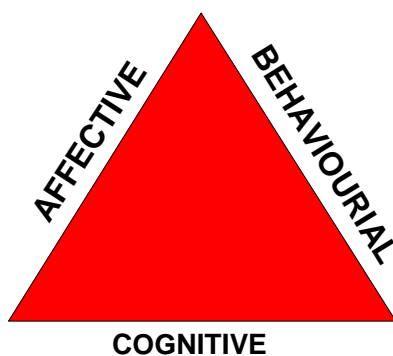


Fig. 1. ABC model Source: Weybrew, 1992

### 3. Measurement methodology

This study addresses the three (3) following questions:

1. What are the LOs which an IHL has established at the T&L levels?
2. Do the performance measurement systems used to evaluate progress on the course LOs in an IHL applicable globally?
3. How are performance measurement system linkages accomplished on the LOs at T&L in an IHL ?

A method of defining the required metrics in Engineering Education Performance Measurement is set forth modelled on Razimah, Plan-Execute-Report-Monitor (PERM) assessment method to measure an Audit performance [1]. This model is found very much agreeable to Shewhart's P-D-S-A Cycle which was subsequently developed into the famous Deming's P-D-C-A Cycle by the Japanese industrial community [3]. This fundamental concept was then adopted by the international community in ISO9000 version 2000 [6]. In IHL, Performance Measurement is the *thing* now.

This attempt is to use a simple statistical technique which can yield very accurate findings using data-driven approach to analyse the root causes of each learning problem encountered. It is a very disciplined approach for assessing students generic skills during a learning process. Communication skill, teamwork, life long learning etc. are generic skills, which we shall termed as dimensions.

**Within these dimensions, relevant main areas related to the subject learning outcomes is then identified but not limited to viz.; vocabulary power, technical appreciation, software development and resourcefulness. Collectively this is known as attributes which are measurable.**

Data analysis utilised is within-case analysis technique. Summary tables of the course LO's were developed for assessment. Finally, a consolidated table shows how the performance measurement system linkages are accomplished on the identified LOs. This tactic improved the probability of developing theoretical models which were a “close fit” with the data. Algorithm of best fit line is determined next.

The assessment form is designed and developed for the attributes which is rated based on an even number scale of 1 – 6 dichotomously indicating **NO** – **YES** with 2, 3 – 4, 5 indicating their level of agreement to an attribute. This assessment form gathers empirical data as the main component of this study. Table 1 shows the conceptual format of the

designed assessment form. See Appendix - A for a sample form.

Dimension A, B...n, is the generic skill to be assessed; communication skills, resourcefulness, adaptability etc. The attributes are finite skills within the dimensions. In writing, it would be grammatical order, logic flow or reasoned arguments. Thus, a holistic discrete method of measurement is developed to enable the respective mean,  $\bar{x}$ , values for each generic skill is established. These values serve as an indicator; on the item easiness and give a locii on the quality level of the respective subject LO [7].

Table 1. Assessment form format

PERFORMANCE SCORE FORM								
Student: XXX YYY				Date: ddmmyy				
Ratings	W	GRADE						G <sub>n</sub> *W
		1	2	3	4	5	6	
Dimension A								
Attribute A1								
Attribute A2								
Attribute A <sub>n</sub>								
Dimension B								
Attribute B1								
Attribute B2								
Attribute B <sub>n</sub>								
Sum (G <sub>n</sub> *W) x Total Allocated Marks								

Table 2 shows the simple computation of an assessment. The lecturer will give his evaluation on the student's performance using the pro-forma form.

Table 2. Simulated assessment

PERFORMANCE SCORE FORM								
Student: XXX YYY				Date: ddmmyy				
Ratings	W	GRADE						G <sub>n</sub> *W
		1	2	3	4	5	6	
Dimension A	40							
Attribute A1					/			
Attribute A2						/		
Attribute A <sub>n</sub>						/		
							%G= $\frac{4+5+6}{18} = 0.83$ $0.83 \times 40 = 33.33$	
Dimension B	60							
Attribute B1				/				
Attribute B2					/			
Attribute B <sub>n</sub>						/		
							%G= $\frac{3+4+5}{18} = 0.67$ $0.67 \times 60 = 40$	
Assignment Score= Sum (G*W) x 6							$33.33+40$ $=73.33\% \times 6$ $= 4.40$	

He will give his own weightage,  $W$  for each dimension which he opine best for the subject, in this case Dimension A=40% and Dimension B=60%. This allows flexibility and freedom for each lecturer to make his own evaluation. This is vital because the lecturer is free to set his own criteria of assessment and let the student know what is expected from the assignment. Next each attribute is given a grade; between 1 - 6 as the lecturer's assessment. In this

exhibit, after grading is done the attributes score in Dimension A is totalled up:

$$\text{Grade Total } A_n = 4+5+6 = 15; n = \text{total attributes} \quad (1)$$

The grade total is then divided by the expected full score;  $G*n = 6 \times 3$ , to give

$$\text{Dimension A factor, } G_A = \frac{15}{18} = 0.83 \quad (2)$$

The raw score for Dimension A is obtained by multiplying the factor with  $W$ , the given weightage of a particular dimension to generate the percentage score for the said dimension;

$$\text{Dimension A}_{RS}, G_A * W = 40 \times 0.83 = 33.33\% \quad (3)$$

Finally, each dimension raw score is then summed up to determine the actual score the student obtained for his assignment;

$$\begin{aligned} \text{Sum } (G_n * W) \times \text{Total Allocated Score} & \quad (4) \\ & = ((0.83 \times 40\%) + (0.67 \times 60\%)) \times 6 \\ & = (33.33 + 40.00)\% \times 6 \\ & = 73.33\% \times 6 \\ & = 4.40 \end{aligned}$$

The assessment is well structured; hence, reliable. The actual score is now more reflective of the students' generic skill ability rather than arbitrarily assessed. FKE allows the liberty at the lecturers hand to decide the type of generic skills they want to assess. However, they have to submit their proposed course outline indicating such assessment. The Head of Departments and the Program Coordinators shall ensure all LO's as determined in the programmes LO Map is duly assessed. Table 3 exhibits a *pro-forma* student's Generic Skill Score Card for a given semester showing the mapped generic skills duly assessed.

Table 3. Engineering Students Performance Evaluation of Generic Skills (ESPEGS) model

STUDENT'S GENERIC SKILL SCORECARD											
Name : Muhammad Saifuddin Program : SEE Sem. I/2005-06 PA: Rozcha A Rashid											
Learning Ability: —											
Kursus	LO <sub>1</sub>	LO <sub>2</sub>	LO <sub>3</sub>	LO <sub>4</sub>	LO <sub>5</sub>	X					
1. SEE1023 - Elektromagnetic Theory	eg. 33/40 = 0.8300	40/60 = 0.6667	-	-	-	0.7083					
2. SEE1123 - Signal & Network	-	-	0.8500	0.7430	-	0.7965					
3. SEE1223 - Comm. Principle	-	0.7186	0.8475	-	-	0.7830					
4. SEE1712 - Electrical Lab	0.6250	0.6413	-	0.8475	-	0.7046					
5. SSE1793 - Digital Numbers	-	-	-	-	-	-					
Ability, Mean ( $P_j$ ) x 4	0.7275 x 4	0.6755 x 4	0.8488 x 4	0.7953 x 4	-	0.7618 x 4					
GSSC <sub>0</sub>	0 <sub>1</sub>	2.91	0 <sub>1</sub>	2.70	0 <sub>1</sub>	3.39	0 <sub>1</sub>	3.18	0 <sub>1</sub>	-	3.05

LO<sub>1</sub>: Communicate LO<sub>2</sub>: Teamwork LO<sub>3</sub>: Life Long Learning LO<sub>4</sub>: Accomplishment LO<sub>5</sub>: Ethic

Ratio of scores for each dimension; say, Dimension A=LO<sub>4</sub> and B=LO<sub>5</sub> is transferred to it's respective columns :

$$\begin{aligned} \text{Dimension A score} & = \frac{33.33}{40} \quad (5) \\ \text{Score ratio factor} & = \frac{33}{40} = 0.83, \quad \text{from } (2) \end{aligned}$$

The whole process is repeated to complete the scorecard by entering all the score ratios for each



subject. This will result in a complete matrix of generic skills assessment of an engineering programme for further evaluation. This method of evaluation on engineering student's generic skills development yield two (2) important data;

1. Value  $\bar{x}$  for each course LO of a student;
2. Value  $\bar{P}_{\text{on}}$  for each dimension.

Value  $\bar{x}$  of all the individual students is then summed up to give the course LO index as shown in Table 4. Value  $\bar{P}_{\text{on}}$  serves as an indicator of each student's ability; strenghts and weaknesses in a particular generic skill. Remedial action can be taken effectively to each specific generic skill without doubt. As shown in Table 5, students can now track their generic skills development on the same scale ranking like the typical technical knowledge report; the base 4 point Cumulative Grade Point Assessment (CGPA).

Table 4. Course learning outcome index

LEARNING OUTCOMES PERFORMANCE MEASUREMENT						
Subject : SEE3512 EMT-1 Section: 12 Sem.1/2005-06 Lecturer: Rozeha A Rashid						
Student's Name	Learning Ability					$\bar{x}$
	LO <sub>4</sub>	LO <sub>5</sub>	LO <sub>6</sub>	LO <sub>7</sub>	LO <sub>8</sub>	
1.Muhd. Saidfudin	0.7275	0.6755	0.8488	0.7953	-	0.7618
2. Student B	0.7638	0.8236	0.7813	0.7536	-	0.7806
3. Student C	0.8360	0.7468	0.7863	0.8136	-	0.7957
4. Student D	0.6638	0.6918	0.7136	0.7014	-	0.6926
5. Student E	0.6415	0.6839	0.8139	0.7632	-	0.7256
<b>OVERALL</b>	<b>0.7265</b>	<b>0.7244</b>	<b>0.7888</b>	<b>0.7654</b>	<b>-</b>	<b>0.7513</b>
Learning Outcome Index; $A_i = \bar{x} \times 100$						<b>75.13%</b>

To compute the Learning Outcome index, each student score ratio average  $\bar{x}$  is obtained from Table 3. This is simply by summing up the student's individual score and averaging the output;

Student A generic skill score;

$$\bar{x} = \frac{\sum x}{N}; N = \text{total no. of subjects} \quad (6)$$

$$= \frac{0.7275 + 0.6755 + 0.8488 + 0.7953}{4}$$

$$= 0.7618$$

This value is multiplied by base 4 to obtain the students' GSSC; i.e. their equivalent academic CGPA pointer score;

$$\text{Student's GSSC} = 0.7618 \times 4$$

$$= 3.05$$

Subsequently, to establish the course LO index, the value  $\bar{x}$  is tabulated as in Table 4. Once each student's generic skills score ratio;  $\bar{x}$  is completed the course LO index can now be established; hence,

$$\text{Course LO} = \frac{\sum \bar{x}}{S}; S = \text{total no. of students} \quad (7)$$

$$= \frac{0.7618 + 0.7806 + 0.7957 + 0.6926 + 0.7256}{5}$$

$$= 0.7513$$

The result above is then multiplied with 100 to obtain the LO index in percentage form. This number is easily interpreted and understood by many;

$$\text{LO index} = 0.7513 \times 100$$

$$\text{LO}_i = 75.13\%$$

In this exhibit, the achievement is commendable. A qualitative scale may be developed with description like; exemplary, commendable, mediocre, poor etc. to give direction whether necessary action need to be done to improve teaching instructions.

Now the students' LO achievements can be tabulated. A hypothetical LO result is shown in Table 5. Competency achieved by each student for each LO can therefore be dissected. This is where assessment by skilled based is more useful. All students may appear to have passed the exam. If we set 70% as the threshold of competency, then Student D is having a problem. Similarly for the lecturer, he has problem developing LO6 and LO8.

Table 5. LO analysis

TABULATION OF MARKS BY LO						
Course : EMT-1 3512 Sem :02 Yr :2007 Lecturer : Rozeha A Rashid						
Students	LEARNING OUTCOMES SCORE					MARKS
	LO4	LO5	LO6	LO7	L08	
1. Razimah	84	75	79	81	80	<b>80</b>
2. Azami	76	82	78	75	78	<b>78</b>
3. Saidfudin	72	68	85	80	76	<b>76</b>
4. Student D	80	79	75	72	70	<b>75</b>
5. Student E	77	76	72	68	66	<b>72</b>
6. Student F	81	72	68	72	76	<b>72</b>
7. Student G	76	74	68	70	66	<b>63</b>
8. Student H	73	72	64	72	70	<b>62</b>
9. Student J	78	71	63	71	64	<b>60</b>
10. Student K	68	67	62	70	62	<b>60</b>
<b>LO mean, <math>\bar{x}</math></b>	<b>79</b>	<b>78</b>	<b>72</b>	<b>74</b>	<b>72</b>	

Given the set of data, it is now possible to establish a link between the students generic skills development and the course LO's. Table 6 shows the student generic skills development over a study period available for longitudinal evaluation. A relationship between an outcome variable; the subject LO<sub>i</sub> and predictor variables; the student's ability and level of generic skills development indicate a strong correlation. This predictor model under scrutiny is developed using the simplified Rasch-Uekawa probability model [8].

Table 6. Students generic skills scorecard

GENERIC SKILLS SCORECARD TRANSCRIPT												
Name : Muhammad Saifuddin Program : SEE Sem.1/2005-06 PA: Rozeza A Rashid												
Learning Ability												
Yr	Session	LO <sub>1</sub>	LO <sub>2</sub>	LO <sub>3</sub>	LO <sub>4</sub>	LO <sub>5</sub>	GSSC					
1	Sem 1-2004/05	2.91	2.68	3.39	3.18	-	3.05					
	Sem 2-2004/05	2.96	2.68		3.39	3.26	3.05					
2	Sem 1-2005/06	3.05	2.68	3.39	3.18	-	3.08					
	Sem 2-2005/06	2.75	2.98	2.68	3.39	3.18	3.37					
3	Sem 1-2006/07	2.85	3.06	3.39	3.18		3.16					
	Sem 2-2006/07	2.85	2.68	2.75	2.68	3.39	3.23					
SUMMARY		$\theta_i$	2.87	$\theta_i$	2.79	$\theta_i$	3.12	$\theta_i$	3.16	$\theta_i$	3.28	3.15

4. Discussion

ESPEG Model is a comprehensive pro-forma evaluation for the required quality criteria known by dimensions and attributes which meets ABET and EAC LO evaluation requirement [9]. ESPEGS is based on marks entries given during an assessment done by a lecturer for a given task. It provides an indicator on the item difficulty for each defined attribute; the generic skills to be accomplished.

Hence, it allows further exploration of this evaluation method using the Rasch-Uekawa Logistic Regression probability model [8];

$$\text{Pr (a Course LO happening)} = \text{Student's Ability} - \text{Difficulty of a given task}$$

The Pr (CLO) value can be derived from score obtained in Table 5; hence the difficulty index. Rasch Model enables each of the Students' Ability; thus students' skill development to be clearly identified by each competency trait. Symptoms of Learning Deficiencies can be traced more effectively and treated specifically.

Table 6 tabulates the students' achievement over their study period. Rasch Measurement enables a more in-depth understanding of the students' true performance. It gives accurate overall indicator of the students' achievement as well. Their geographical movements and actual locii are clearly plotted on the item map showing their extend of ability for a given task. Fig. 2 shows the learning landscape and the student's respective geographical position in relation to the items and their learning ability.

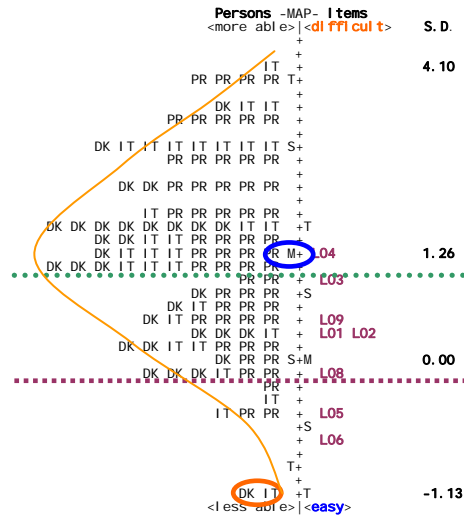


Fig. 2. Rasch Model Person Item-Map

This map showing the position of persons in relation to the items will help guide academicians to respond with certainty on the nature of corrective actions to be taken. Teaching methods may be reviewed and new approach is developed and tested. Teaching style may need some creative innovations to stimulate learning ambience.

Therefore, the student's ability development may be tracked over their study period and teaching method and style may be improved to facilitate such latent development. Symptoms of student's weaknesses in certain generic skill trait can be traced more effectively and easily. Similarly, students who excel can be equally tracked. The assessment form though dichotomous, used ordinal variables and they are not linear measures. By applying Rasch Model this problem of giving context to the data is solved. An algorithm to link the correlation can now be established [10]. This algorithm will help us to give students the best experiential learning as well as provide a benchmark for the lecturers to improve their teaching competencies. More study is needed to identify the root causes of the items and person outfits.

5. Conclusion and recommendations

This simple but prudent conceptual theoretical framework of measurement is capable of examining an engineering course LO in great depth and width. It is capable of providing multi-faceted views yet specific and objective measurement on the LOs established by an IHL.

This measurement model uses empirical data directly from the lecturers assessment on a student for a given task. This PMS results in more accurately classified examinees. The statistical technique employed very fundamental statistical approach;

mean and mean average, and simple linear equation thus, globally applicable.

ESPEGS Model enables each LOs to be evaluated discretely. LO index generated gives a fair view on the course LO achievement. Though the measurement model is able to show reliably accurate result with small number N, the dimensions affecting the performance of a teaching method shall be subjected to further study.

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*Appendix A*



**Fakulti Kejuruteraan Elektrik  
 UNIVERSITI TEKNOLOGI MALAYSIA, SKUDAI, JOHOR**

**Written Report Evaluation Form**

Report Topic:  
 Course Number and Title:  
 Date:  
 Student Name(s):

*Assign a weight (W) for each dimension to be evaluated. Sum of weights is 100. Rank each criterion by assigning a numerical grade (G) from lowest 1 to highest 6.*

	Weight (W)	Grade (G)						W*G
		1	2	3	4	5	6	
<b>1. Writing Communication skills.</b>								
<i>i. Correct usage of grammar, spelling, and punctuation.</i>								
<i>ii. Concise and cohesive sentence structures.</i>								
<i>iii. Appropriate vocabulary for subject matter.</i>								
<i>iv. Report is well structured.</i>								
<b>2. Appropriate use of softwares /visual tools.</b>								
<i>i. Clear diagrams, photos, and graphs are used when needed.</i>								
<i>ii. Visuals are correctly labelled and referenced.</i>								
<b>3. Logical presentation of ideas and solutions.</b>								
<i>i. Ideas are developed and supported in a logical manner.</i>								
<i>ii. Engineering principles/ software are well developed.</i>								
<b>4. Quality of technical information, resourcefulness.</b>								
<i>i. Resourceful and materials clearly referenced / cited.</i>								
<i>ii. Precise technical knowledge/ information is presented.</i>								
<b>5. Quality of outcomes presented.</b>								
<i>i. The material presented supports outcomes.</i>								
<i>ii. Quality of recommendations and discussion is appropriate.</i>								
<b>6. Overall report quality</b>								
<i>i. Intended objectives are met.</i>								
<i>ii. The material is covered in a comprehensive manner.</i>								
<i>iii. Ideas presented reflect originality and innovative thinking.</i>								
<b>7. Others – Teamwork</b>								
<b>Total % / Mean <math>\bar{G} =</math></b>								

**GRADE =  $\sum (W * G) =$  \_\_\_\_\_ %**

Comments:

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## **The Effect of Changing the Medium of Instruction on the Performance of Aeronautical Engineering Students**

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### **Abstract**

In July 2004 the medium of teaching of all subjects at the Faculty of Mechanical Engineering was changed to English. This study compares the performance of four batches of Aeronautical Engineering students in core engineering subjects, two batches before the change and two batches after. From this study it was demonstrated that students' academic performance was significantly affected by the change in the medium of instruction.

**Keywords:** Medium of instruction; aeronautical engineering; academic performance

### **1. Introduction**

Towards the end of 2002, the then Prime Minister, Dato' Seri (now Tun) Mahathir bin Mohamad, declared that the teaching of Science and Mathematics subjects in the national education system be carried out in English, effective from the coming schooling year in January 2003. The rationale of this drastic move was to stem the decline in the level of English proficiency amongst Malaysian professionals and to enable Malaysia to compete on equal footing with more advanced nations in global markets. The directive was implemented by the Ministry of Education in steps from 2003, with the batches enrolling that year in Standard One in primary schools, Forms One and Lower Six in secondary schools, and the matriculation colleges at tertiary level [1,2].

In Universiti Teknologi Malaysia (UTM) the teaching of classes in English language was made compulsory for all courses offered to the new batch of 2004/2005 academic session intake. The move was undertaken to streamline with the recent government policy as well as to attract international students to enroll in UTM. Right from the beginning UTM did not face much difficulty in implementing the new policy as most of the academic staff involved has been educated in English-based background at one time or another, the majority of them graduating from universities in English-speaking countries overseas.

These study overviews the effects to the UTM student as a result of the change of the medium of communication and education to English. Due to the constraints of time the sample of the study was confined only to Aeronautical Engineering students at the Faculty of Mechanical Engineering, taking two batches before the change was implemented and two batches after. The courses observed in the study for comparison were the Faculty core engineering courses.

### **2. Background**

The Aeronautical Engineering degree program was initiated in UTM in 1983 with the collaboration of Royal Malaysian Air Force, following the graduation of the first batch of students of the diploma program that year. The program was implemented as a variation of the Mechanical Engineering program, with the first three years of the total five years common with the mainstream Mechanical Engineering program.

Since the beginning the medium of instruction has always been in the national language i.e. Bahasa Malaysia, in accordance with the Education Act 1961, and the revised National Education Policy of Malaysia declared by the second Prime Minister, Tun Abdul Razak bin Hussein, in 1970. However, even though all official functions such as tests and examinations were prepared in Bahasa Malaysia, classes and interactions were in general conducted bi-

lingual as most available references were in English. As such, on the whole, students were familiar with the specialised and technical terms used, both in Bahasa Malaysia and in English. Language then was not an issue; rather what was more emphasised was the understanding of the subject matter taught.

Since the implementation of the new directives in 2004, all teaching in Bahasa Malaysia for the specified subjects was prohibited. All lectures and classes were to be conducted in English, and all assessments and examination questions must be prepared in English, even though during the first few semesters Bahasa Malaysia translations were also provided.

### 3. Methodology and Findings

For the purpose of this study, four batches of students of the Bachelor of Engineering (Mechanical – Aeronautics), two batches before the changeover of medium, i.e. from intakes of the 2002/2003 and the 2003/2004 sessions, and two batches after, from intakes of the 2004/2005 and 2005/2006 sessions, were considered as given in Table 1 below.

Table 1. Sample of study

Medium of instruction	Batch	No of students	Notes
Bahasa Malaysia	AM02 (2002/2003)	32	5 years program; intake with SPM
	BM03 (2003/2004)	32	5 years program; intake with matriculation
English	AM04 (2004/2005)	41	4 years program; intake with matriculation/STPM
	AM05 (2005/2006)	33	4 years program; intake with matriculation/STPM

The AM02 students were admitted into the Faculty based on their SPM results and underwent the five year curriculum. The BM03 students were taken in based on their matriculation results, which was taken one year after their SPM examinations, and also undergoing the five year curriculum with several science and mathematics subjects exempted (since they have done these during matriculation). The AM04 and AM05 groups were accepted to the program based on their matriculation results and took the revised four-year curriculum, which was implemented after the Ministry directed that SPM

results were no longer to be used for university intake.

All these batches were the main groups for every intake; there were other much smaller intakes based on other criteria such as Diploma results, but these were not considered in this study since they did not form the mainstream group and may have been exempted from some courses studied here.

For each of the students' nine courses (subjects) in the Mechanical Engineering (Aeronautics) undergraduate program as listed in Table 2 were observed. These, and only these, courses were chosen because they are the core compulsory courses for the program with a higher passing grade (of C-) and would be able to reflect a student's overall performance in the Mechanical Engineering (Aeronautics) program. The average grade points for each batch for each subject were then calculated and compared, as given in Fig. 1(a) to Fig. 1(d).

Table 2. Core Courses Considered

Level	Courses/Subjects
Bachelor of Engineering (Mechanical - Aeronautics)	Statics Mechanics of Solids I Dynamics Mechanics of Fluids I Thermodynamics I Mechanics of Solids II Mechanics of Machines Mechanics of Fluids II Thermodynamics II
SPM	English Mathematics Physics Chemistry

To benchmark any possible variation of the student's academic abilities between batches their SPM results in Science, Mathematics and English subjects (as also listed in Table 2) were also noted and average computed. In order to facilitate comparison with the University grade points, the SPM results, given in terms of grade 1 (distinction) down to grade 9 (fail), were converted to equivalent grade points from 4.0 down to 0.0.

The average performance between the batches in the core courses in terms of grade points and average SPM English and average SPM Science and Mathematics in terms of equivalent grade points was compared. The respective graphs are plotted in Fig. 2.

Table 3. Average Core Course Results

Batch	Statics	Mechanics of Solids I	Dynamics	Mechanics of Fluids I	Thermodynamics I	Mechanics of Solids II	Mechanics of Machines	Mechanics of Fluids II	Thermodynamics II
AM02	3.38	3.22	3.44	3.18	3.19	3.01	3.56	3.12	3.33
BM03	3.27	3.40	3.30	3.26	3.47	2.55	3.36	3.25	3.38
AM04	2.58	2.59	3.09	3.17	3.25	2.53	3.27	2.72	2.94
AM05	3.59	2.92	3.01	2.90	3.05	2.20	2.91	3.49	2.31

Table 4. Comparing Core Courses and SPM Average Results

Batch	Faculty Core Courses Average	English		Science and Mathematics	
		SPM Grade Average	Equivalent CPA Average	SPM Grade Average	Equivalent CPA Average
AM02	3.27	2.37	3.31	1.41	3.80
BM03	3.25	4.68	2.16	2.66	3.17
AM04	2.90	3.48	2.76	1.86	3.57
AM05	2.93	2.97	3.01	1.48	3.76

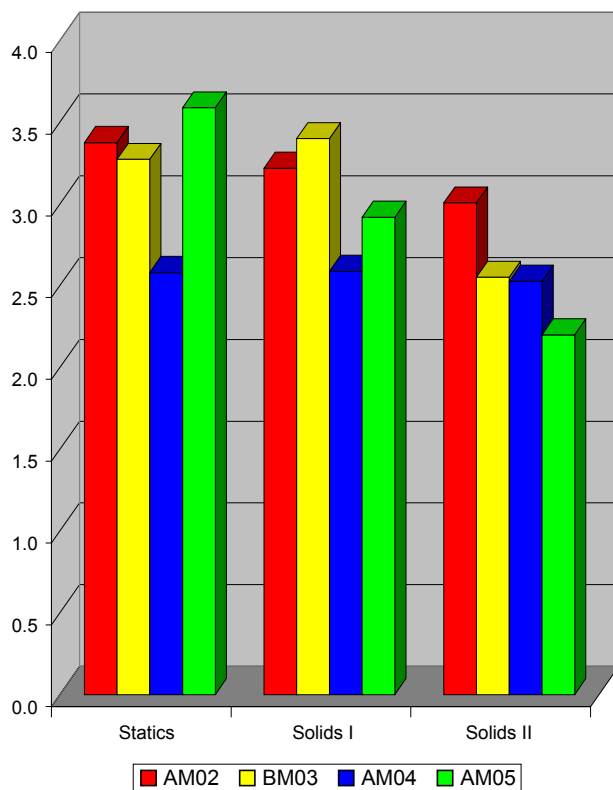


Fig. 1(a). Performance in Statics and Mechanics of Solids I & II.

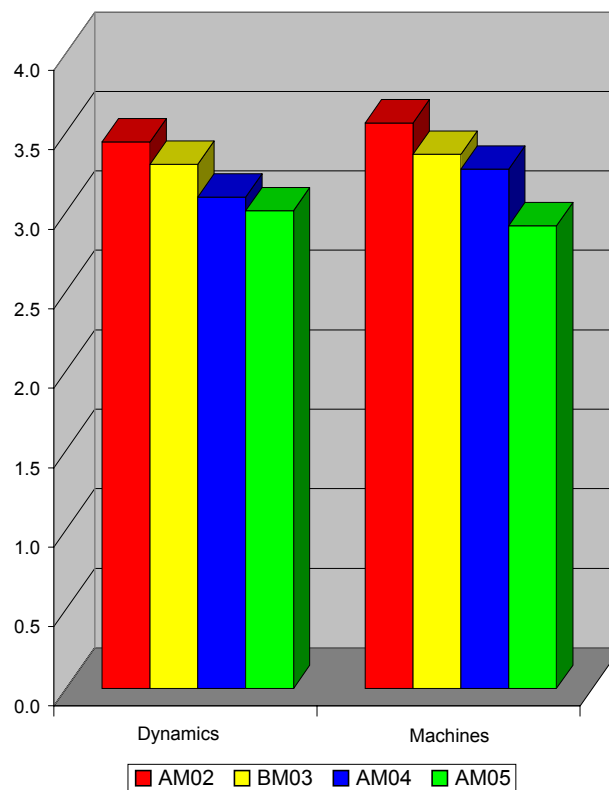


Fig. 1(b). Performance in Dynamics and Mechanics of Machines.



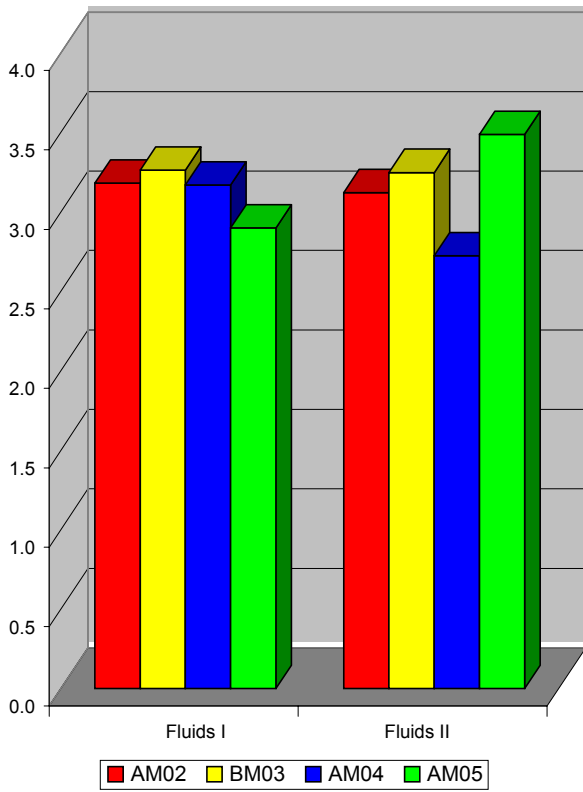


Fig. 1(c). Performance in Mechanics of Fluids I & II.

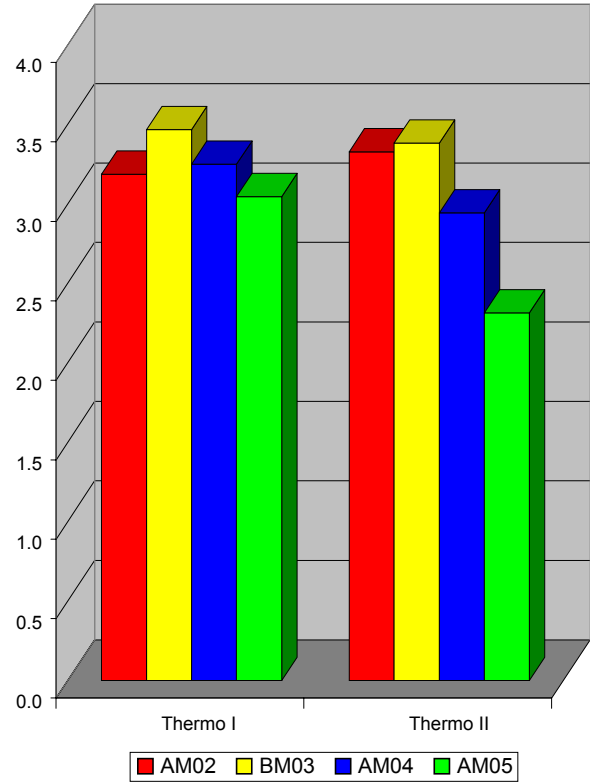


Fig. 1(d). Performance in Thermodynamics I & II.

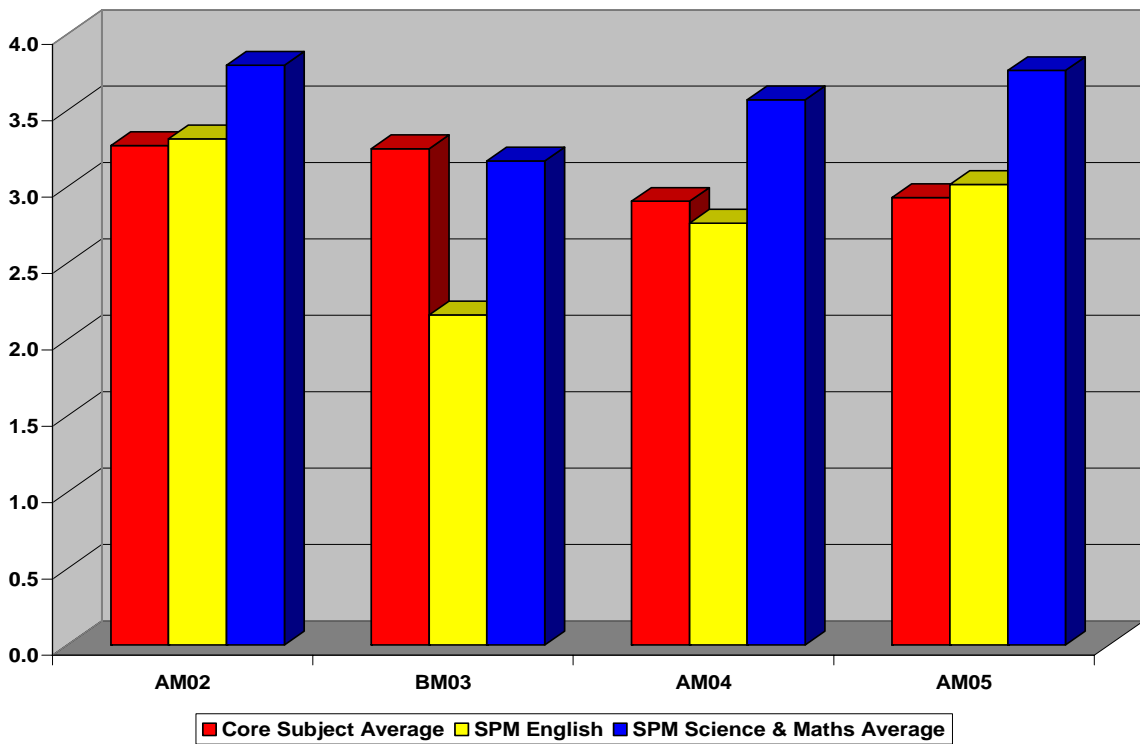


Fig. 2. Comparing average performances in core courses, SPM English and SPM Science and Mathematics.

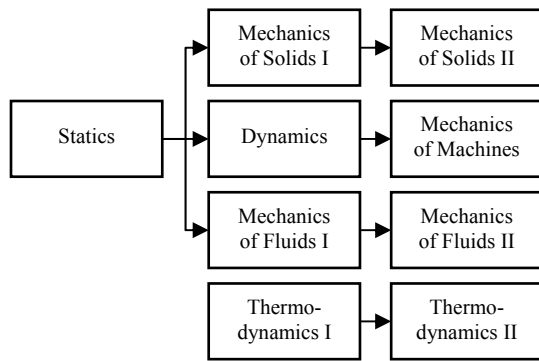


Fig. 3. Prerequisite flowchart of the courses.

#### 4. Discussions

The nine core courses chosen for this study are from the four fundamental fields of the program as shown in Fig. 3 below, with the courses to be taken in sequence within each area during the first two years of the program. Fig. 1(a) to Fig. 1(d) show the performance of students from four different batches in these fields. Statics, though is represented here only in Fig. 1(a), is also prerequisite to the other areas of Mechanics of Fluids and Dynamics/ Mechanics of Machines. As such a good grasp of Statics would be essential towards the understanding of the courses downstream.

An observation of Fig. 1(a) to Fig. 1(d) shows a general trend of a decline in the overall performance as the medium of instruction was changed from English language to Bahasa Malaysia after 2003. This is confirmed by Table 4 and Figure 2, where the average grade points of the nine core subjects dropped from 3.27 and 3.25 respectively for the two batches before the change, to 2.90 and 2.93 for the batches after the change. These represent a significant deterioration of about 10.5% in the averages.

Referring to Fig. 1(a), group AM02 shows better overall results for all three subjects, namely Statics, Mechanics of Solids I and Mechanics of Solids II. This is due to their SPM Science and Mathematics (SPM S&M) results were better among the four even though AM05 have almost the same SPM S&M results. This indicates that even though they have almost the same SPM S&M results, but since the AM05 groups were taught in English as opposed to the AM02 group their results were much lower.

There seemed to be an anomaly in the Statics result shown by the AM05 group where they have the highest overall results (3.59) even though the medium of instruction was in English. However, this was found to be due to a particular lecturer teaching this group of students. He was known to be very lenient. This is reflected in Mechanics of Solids II (average grade point of 2.20) where this group of students, even though they have the highest Statics results but they

also exhibit the lowest Mechanics of Solid II results. This is indicative of the student knowledge in this particular course.

Fig. 1(b) shows that there is a good correlation between Dynamics and Mechanics of Machines courses. This can be seen clearly that those who scored good grades in Dynamics also scored highly in Mechanics of Machines, with slightly better results for the latter. Again AM05 group showed the lowest overall results even though their Statics results were the highest. The trend shows that those two groups taught in English showed lower results compared to those taught in Bahasa Malaysia.

Fig. 1(c) shows no significant effect on the overall results even those taught in English language. This is reflected in the graph as for Mechanics of Fluids I, all four groups showed the comparable performances except for AM05 group that shows a slightly lower result. However for Mechanics of Fluids II results there is again an anomaly in the overall results for the AM05 group, with an exceptionally high overall result of 3.49. This is again thought to be due to the same reason as that for Statics earlier where this course (Mechanics of Fluids II) was taught by the same particular lecturer (who has now left the University). However, an observation can be drawn to AM04 group where they have the lowest Mechanics of Fluids II result which is more relevant here since they were taught in English as compared to AM02 and BM03 groups.

Fig. 1(d) shows significant deterioration in the performance of students when the medium of instruction was changed from Bahasa Malaysia to English language. This is very clear for Thermodynamics II where both AM04 and AM05 showed the two lowest results as compared to AM02 and BM03. This is very surprising since the SPM S&M results for AM04 and AM05 were much better than the BM03 group, but the BM03 group showed the highest Thermodynamics II results. This again indicates the important of medium of instruction on the student performances.

This can be attributed to their understanding of the fundamentals in Mechanical Engineering. Since most of these students have poor English language background, they were forced to learn in a language that they are not comfortable with and most of these students are a bit shy to ask their lecturer when they do not understand. This again contributes to the deterioration in their performances. This fact is supported by a study done by Aniza et al [3] on a group of Matriculation students that shows that the medium of instruction does affect the student performance since they learn during their secondary school all the terminology in Bahasa Malaysia. Suddenly they have to adjust to the new terminology. This slightly affected their performance.

Another point that needs to be established here is whether it is fair to compare these results, whereas the

student's actual capabilities might be different. The SPM S&M results of the students as shown in Figure 2 however assure us that the deterioration was not due to their capabilities, since the performances of batches AM02, AM04 and AM05 are comparable. In fact surprisingly the performance of the BM03 group in the core courses was the best even though their SPM S&M results were the worst. Also the fact that their SPM English was the lowest (and far down) only proves that good understanding of Engineering can be attained in Bahasa Malaysia.

This once again emphasizes the fact that the medium of instruction is very important for students' mastery of a course. If one relates to Bloom's Taxonomy [4] of the hierarchy of learning, one's ability to acquire factual knowledge – which is the most basic step in learning – is very much related to the medium in which that knowledge is being conveyed. Consequently if they cannot acquire the facts, their performance in higher levels of learning would be greatly affected.

The importance of the medium of instruction to the acquisition of knowledge, engineering or otherwise, has similarly been demonstrated in several other reports [5, 6, 7, 8].

## 5. Conclusion

From the study conducted it was demonstrated that there was a significant effect on the academic performance of Mechanical Engineering (Aeronautics) students arising from the change of the medium of instruction from Bahasa Malaysia to English.

## 6. Acknowledgement

The authors would like to thank the Dean of the Faculty of Mechanical Engineering UTM for his cooperation and support towards preparing this paper.

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## Students' Perceptions on the Use of English as the Medium of Instruction for Mechanical Engineering Programs

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### Abstract

The medium of instruction of all courses at the Faculty of Mechanical Engineering, Universiti Teknologi Malaysia (UTM), was changed from Bahasa Malaysia to English from the 2004/2005 academic session. This paper investigates the perception of students on the use of English Language to teach Mechanical Engineering Programs in UTM. From this survey conducted it can be shown that in general the students perceive the use of English positively, appreciate its importance but at the same time it seems that their efforts in improving their command of English need to be increased. Furthermore, the students do not perceive the teaching of engineering courses in English as hampering their academic performance.

**Keywords:** Medium of instruction, mechanical engineering, academic performance, students' perceptions

### 1. Introduction

In response to the directive by the government that the medium of instruction for Science and Mathematics be changed to English from 2003 [1,2], Universiti Teknologi Malaysia started to implement teaching of classes in English for all courses for all batches of students enrolling from the 2004/2005 academic session intake.

The rationale of this drastic move was to stem the decline in the level of English proficiency amongst Malaysian professionals and to enable Malaysia to compete on equal footing with more advanced nations in global markets. In UTM, aside from streamlining with the recent government policy, the move was also made to attract international students to enrol in the university, hence improving UTM's standing for ranking purposes.

Right from the beginning UTM did not face much difficulty in implementing the new policy as most of the academic staff involved have been educated in English-based background at one time or another, the majority of them graduating from universities in English-speaking countries overseas.

This study surveys the perceptions of Mechanical Engineering students in UTM on the change of the medium of communication and education to English. A questionnaire containing 20 key questions was designed and distributed to a sample of 254 current students from various engineering programs in the Faculty of Mechanical Engineering, and the results obtained are analysed and reported here.

### 2. Background

After the changeover of the medium of instruction for engineering programs in UTM from Bahasa Malaysia to English was implemented in July 2007, there is a need to gauge the effect of the change on the performance of the students, especially amongst the students at the Faculty of Mechanical Engineering, and hence take suitable follow-up actions.

A recent study by Abdul-Latif *et al* [3] showed that there was significant deterioration in the performance of students after the changeover. From here there is a need to exactly pin-point the possible factors which might lead to the deterioration so that proper corrective measures be drawn.

Several studies by many earlier researchers raised the issue of students finding difficulties in understanding the subject matter when the medium of instruction was different from the language they normally use in daily communication [4, 5, 6, 7, 8].

Patil and Riemer [9] suggested that in order to improve the students' acquisition of communication skills within the engineering and technology curricula at Maharashtra State, India, the writing and speaking skills in English can be improved by greater collaborative and networking programmes with renowned educational institutes worldwide.

It is thus important to gauge students' attitude towards the use of English, their own experiences in communicating in the language, and other factors that could affect their command of the language.

### 3. Methodology and Findings

For the purpose of this study, a survey was conducted on a sample of students from the Faculty of Mechanical Engineering, Universiti Teknologi Malaysia. This survey was done both during some classes at the faculty with the help of class lecturers, as well as at a students' residential college through the college principal.

The instrument used in the survey is a one-sheet questionnaire consisting of two parts: Part 1 on the respondents' details, and Part 2 with twenty questions on students' perceptions on the use of English Language in teaching and learning. A copy of the questionnaire is given in the Appendix.

For Part 1 students are requested to indicate their background information, such as sex, program, type and year of enrolment to the program, English proficiency level, the latest grade points, schooling background before university enrolment, language of communication used at home and between peers, and parents' occupational background. The purpose of this information is to find the correlation between the various students' background and their perceptions.

For the purpose of this short paper however, only the effects of schooling background and year of intake was observed and considered. For the schooling background the bulk of the respondents come from either fully residential schools, government schools in urban areas or government schools in rural areas. The numbers in the categories of private schools, whether Chinese, English or Religious schools, are too small and insignificant (one in each) to provide a reflection of the effects of these schools. A detailed breakdown of the respondents is given in Table 1.

**Table 1 Respondents**

Year	Res. Sch.	Urban	Rural	Pvt. Chin.	Pvt. Engl.	Pvt. Relig.	Total
03/04	7	3	5	0	0	0	15
04/05	20	19	16	0	0	0	55
05/06	31	25	18	1	1	0	76
06/07	12	19	14	0	0	0	45
07/08	23	32	7	0	0	1	63
<b>Total</b>	<b>93</b>	<b>98</b>	<b>61</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>254</b>

The twenty questions given in Part 2 were designed to probe students' perceptions in six key issues as given in Table 2.

To each of the twenty questions respondents were requested to indicate their levels of agreement to the given statements, from "strongly agree" (5), down to

"agree" (4), "neutral" (3), "disagree" (2) or "strongly disagree" (1).

**Table 2 Key issues**

No	Issues	Questions
1	Students' proficiencies in English, both oral (O) and written (W)	1, 14 (O) 12, 18 (W)
2	Students' usage of English	6, 9, 16
3	Efforts towards improvements	4, 10
4	Use of English in teaching and learning, both student-related (S) and teacher-related (T)	3, 5, 8 (S) 2, 7, 20 (T)
5	The effect of using English as the medium of instruction on students' academic performance	13, 19
6	Importance of English language	11, 15, 17

It should be stressed here that the questions were intended to probe students' perceptions and only these, which may or may not coincide with the reality. For example a student may perceive that his proficiency of the English language is good whereas actual empirical tests might indicate otherwise.

### 4. Discussions

Figure 4 summarizes the survey that has been done on 254 students from several programs at Faculty of Mechanical Engineering. Most of the students regardless of intake year and program gave similar pattern of responses. However, in this paper only the overall average results is presented.

From Figure 4, it can be seen that most of the students are convinced that the teaching of engineering courses in English is beneficial for their future, i.e. for them to pursue higher degree in engineering and maybe to further their studies overseas where the medium of teaching is usually in English language. The response was 3.96 (in the range between 1 and 5), which means that the students are really convinced, since nowadays most of the references and journals are in English. This is reflected from Question 15 (Q15 in the figures) and the sample question is presented in the appendix.

Question 17, (Q17) furthermore emphasizes the fact that the students are mostly in agreement that the usage of English language as a medium of instruction for engineering courses helped them to improve their English language. This is reflected by the response of 3.72 overall, with no significance variation between the various schooling backgrounds (Figures 1-3).

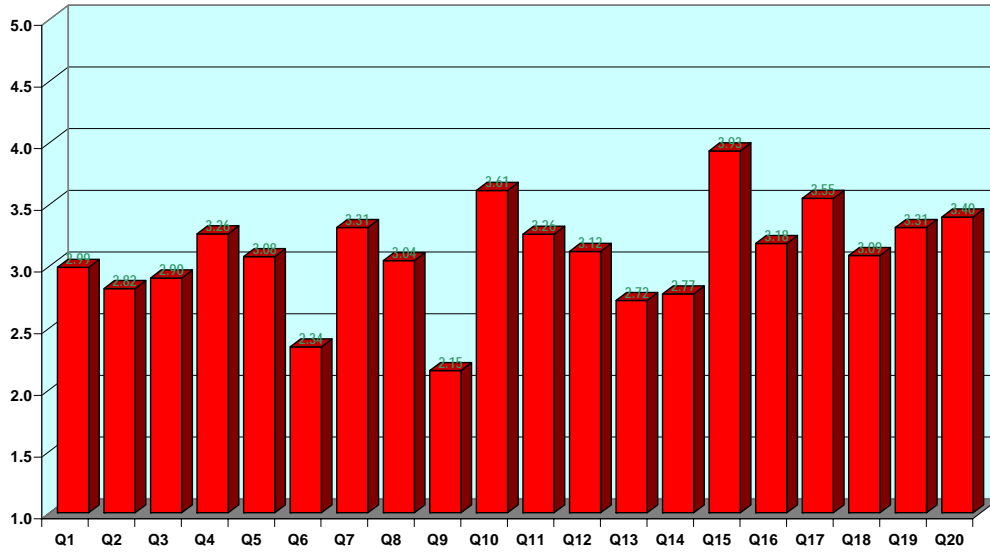


Figure 1: Average Responses to the Questions (Residential School Leavers)

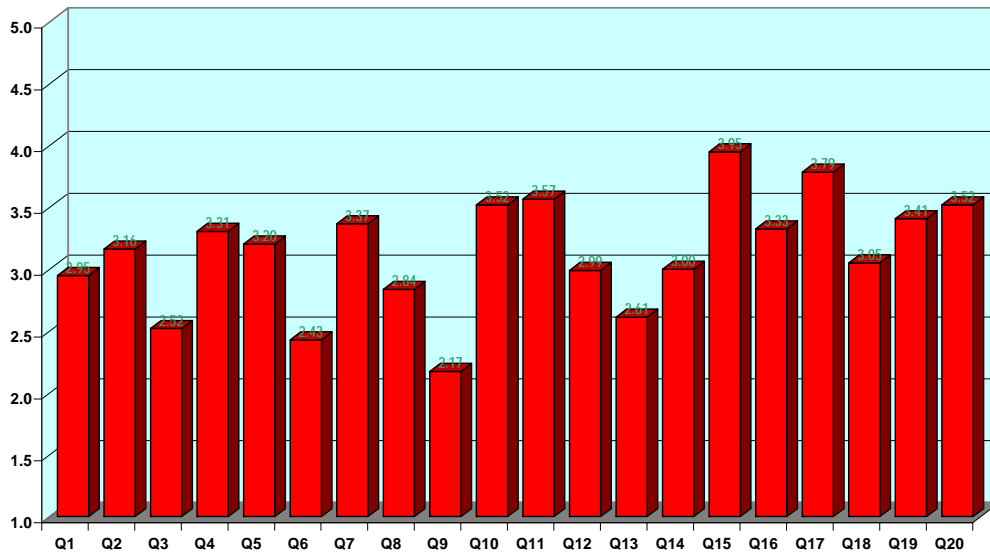


Figure 2: Average Responses to the Questions (Urban School Leavers)

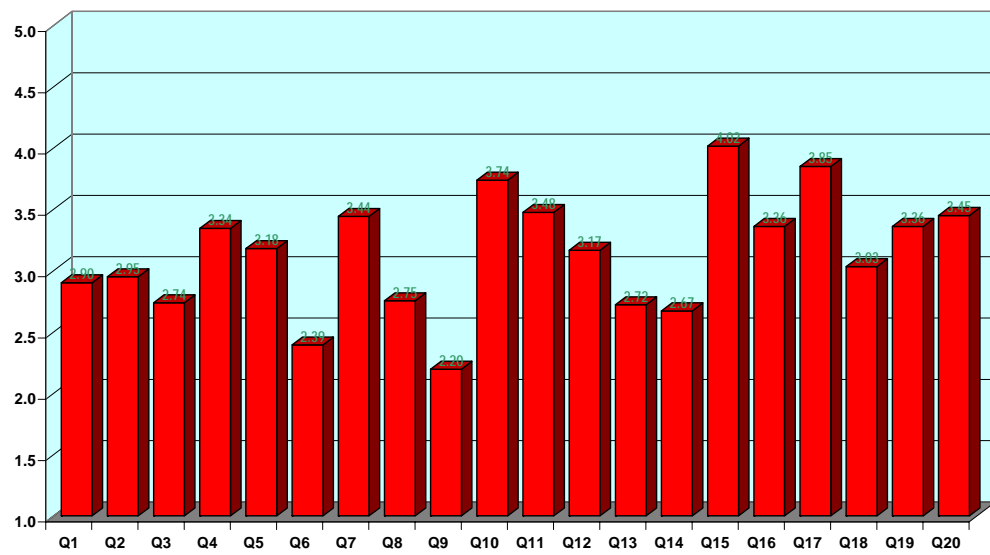
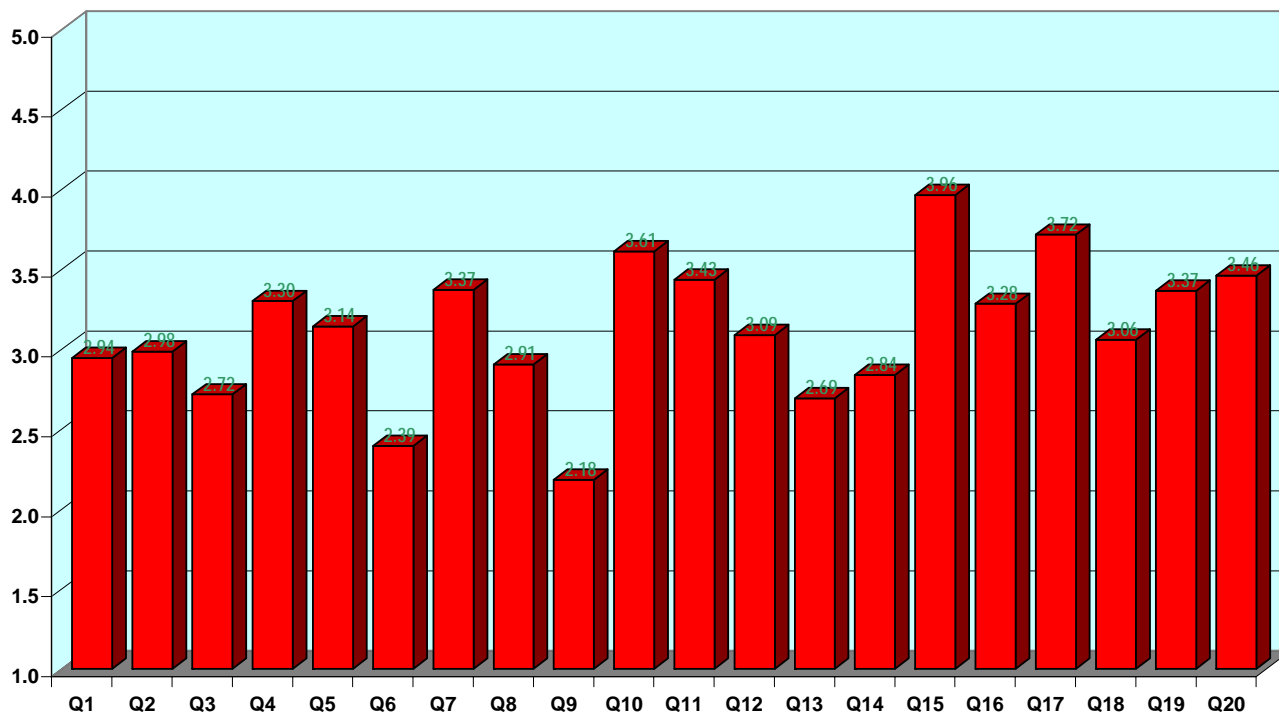


Figure 3: Average Responses to the Questions (Rural School Leavers)



**Figure 4: Overall Average Responses to the Questions**

Even though most of these students have very little or poor English background, but most of them still feel that the teaching of engineering courses in English helped them improves their command of English since most of them have to do presentation of projects and assignments in English. This somehow forces the students to improve their English since most of the materials they have to present are in English and their presentation must also be in English.

On the contrary, in Question 9 (Q9), the students disagree that they prefer to speak in English rather than any other languages in their daily conversation. This is reflected in Figure 4, where Q9 shows that the response is 2.18. This trend is similar across board as reflected in Figures 1-3. This shows that most of the students do not speak in English in their daily conversation.

This is further proved by Question 6 (Q6) from Figure 4 where the students disagree that they usually discussed with their classmates in English regarding their class subjects. These two questions (Q9 and Q6) clearly show that the students either consciously or subconsciously did not make much effort to improve their English either by discussing with their classmates on the subject matter or even in their daily conversations. This actually reflects that the students from all schooling background only use English language in classes because there are instructed to do so by the authorities.

This phenomenon is actually reflected by Abdul-Latif *et al* [3], where they found out that the students performance was markedly reduced since the introduction of English as the medium of instruction in engineering academic programs.

This is also supported by the work by Evans [10] with a case study using data from the department of engineering at the Hong Kong Polytechnic University (HKPU). He found out that even after several decades of introducing English as a medium of instruction in the engineering stream at the tertiary level in Hong Kong

Similarly, even though English language was started as the medium of instruction in the engineering stream since 1911 at the University of Hong Kong, the level of proficiency in English was not as high as might be expected [11].

The study by Evans shows that the students in HKPU still prefers to communicate orally in their mother tongue (Cantonese) rather than in English with only 4% of the respondents said that they communicate even with their lecturers about non-academic matters in English. Even only 1% of the respondents chat with their classmates in English on work related discussions.

Furthermore, this survey shows that the confidence of urban school leavers in using English is clearly greater than the residential school and rural school leavers as indicated by their responses to Questions 2, 3, 11 and 14. This seems to correlate to the fact that the use of English is expected to be more prevalent in urban schools.

## 5. Conclusion

From the study it is observed that students generally consider English Language important and good for their future, want to improve their proficiency in it, think learning in English is fun, but on the other hand do not



seem to be putting enough effort to improve their command of the language.

Also, the study shows that the students do not perceive teaching engineering in English as hampering their academic performance.

## 6. Acknowledgement

The authors would like to thank the all the lecturers and the students involved in conducting this survey.

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Appendix: Survey Questionnaire

**KAJISELIDIK PENGGUNAAN BAHASA INGGERIS  
DALAM PEMBELAJARAN PELAJAR  
KEJURUTERAAN MEKANIKAL UTM**

---

**Bahagian 1 : Maklumat Responden**

1. Jantina  Lelaki  Perempuan
2. Kursus  SMM  SMB  SMI  SMK  
 SMP  SMT  SMV
3. Kod Kemasukan  AM  BM  CM
4. Tahun Kemasukan  02/03  03/04  04/05  05/06  
 06/07  07/08
5. Gred Bahasa Inggeris SPM \_\_\_\_\_ MUET (jika ada) \_\_\_\_\_
6. Gred Terkini CPA \_\_\_\_\_ GPA \_\_\_\_\_
7. Jenis Sekolah  Sekolah Harian Kerajaan Dalam Bandar  
 Sekolah Harian Kerajaan Luar Bandar  
 Sekolah Berasrama Penuh  
 Sekolah Swasta Cina  
 Sekolah Swasta Inggeris  
 Sekolah Swasta Agama
8. Bahasa Pertuturan Di Rumah  Melayu  Inggeris  Cina  
 Bumi Sarawak  Bumi Sabah  India  
 Lain-lain: \_\_\_\_\_
9. Bahasa Pertuturan Dengan Kawan  Melayu  Inggeris  Cina  
 Bumi Sarawak  Bumi Sabah  India  
 Lain-lain: \_\_\_\_\_
10. Laterbelakang Pekerjaan Ibubapa  
Bapa Ibu  
  Profesional (selain guru)  
  Guru  
  Ahli Perniagaan/Usahawan  
  Separa-profesional (J/teknik, J/rawat dsb)  
  Petani/Penternak/Nelayan  
  Pekerja Pejabat (Kerani/Jurutaip dsb)  
  Buruh/Pekerja Am/Pembantu Rumah  
  Penganggur  
  Surirumah  
  Pesara (tandakan juga pekerjaan sebelum)

## Bahagian 2 : Persepsi Terhadap Bahasa Inggeris

Sila bulatkan satu sahaja jawapan yang berkaitan berdasarkan kod berikut:

Sangat Tidak Setuju (STS)	Tidak Setuju (TS)	Neutral (N)	Setuju (S)	Sangat Setuju (SS)
1	2	3	4	5

No	Soalan	STS	TS	N	S	SS
1	Saya merasa kebolehan lisan saya dalam Bahasa Inggeris adalah pada tahap yang baik	1	2	3	4	5
2	Saya lebih senang memahami penerangan pensyarah saya dalam Bahasa Inggeris berbanding Bahasa Malaysia	1	2	3	4	5
3	Penggunaan Bahasa Inggeris menyukarkan pemahaman saya dalam sesuatu subjek berbanding Bahasa Malaysia	1	2	3	4	5
4	Saya akan berusaha menggunakan Bahasa Inggeris dalam perbincangan kelas	1	2	3	4	5
5	Saya lebih memahami bahan rujukan dalam Bahasa Inggeris	1	2	3	4	5
6	Saya selalu berbincang mengenai pelajaran dalam Bahasa Inggeris dengan rakan-rakan sekelas	1	2	3	4	5
7	Secara amnya saya selesa dengan pengajaran dalam Bahasa Inggeris oleh pensyarah saya	1	2	3	4	5
8	Saya menghadapi masalah memahami banyak istilah Bahasa Inggeris yang digunakan dalam kelas	1	2	3	4	5
9	Saya lebih banyak bertutur dalam Bahasa Inggeris dalam perbualan seharian berbanding bahasa lain	1	2	3	4	5
10	Saya sentiasa berusaha meningkatkan kemahiran saya berkomunikasi dalam Bahasa Inggeris	1	2	3	4	5
11	Saya berpandangan lebih baik pengajaran dibuat dalam Bahasa Inggeris berbanding Bahasa Malaysia	1	2	3	4	5
12	Saya lebih yakin untuk menjawab soalan peperiksaan dalam Bahasa Malaysia berbanding dengan Bahasa Inggeris	1	2	3	4	5
13	Pengajaran dalam Bahasa Inggeris menurunkan markah saya dalam sesuatu subjek berbanding Bahasa Malaysia	1	2	3	4	5
14	Saya lebih yakin menggunakan Bahasa Inggeris dalam perbincangan saya dengan pensyarah mengenai pelajaran	1	2	3	4	5
15	Saya yakin bahawa penggunaan Bahasa Inggeris lebih bermanfaat untuk masa depan saya	1	2	3	4	5
16	Pembelajaran dalam Bahasa Inggeris lebih menyeronokkan berbanding dalam Bahasa Malaysia	1	2	3	4	5
17	Pengajaran Bahasa Inggeris dalam kelas kejuruteraan banyak membantu saya menguasai Bahasa Inggeris	1	2	3	4	5
18	Saya berkeyakinan menyampaikan pandangan saya melalui penulisan dalam Bahasa Inggeris	1	2	3	4	5
19	Saya dapat meningkatkan prestasi akademik saya dengan belajar dalam Bahasa Inggeris	1	2	3	4	5
20	Saya merasakan tahap penguasaan Bahasa Inggeris pensyarah-pensyarah saya amat baik dan mudah difahami	1	2	3	4	5