Case Studies of Using a Template File for GPA Calculator in Academic Advising Activities at Universiti Tenaga Nasional

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Abstract

Academic advising is a systematic process intended to aid students in achieving educational, career, and personal goals. Correct academic advising is one factor that contributed to students successfully graduated from their studies, especially for students who are near the border of passing or failing the program. One important tool in academic advising is a **G**rade **P**oint **A**verage (**GPA**) calculator. This paper describes the development of a template file for GPA calculator at UNITEN and its features. Utilizing the template file, academic advisors at UNITEN are able to monitor GPA, take appropriate action when necessary, guide their advisees doing proper study plan (for achieving a targeted GPA), able to simulate and set the realistic semester GPA target for their advisees based on GPA histories and capabilities. Case studies related to the use of the template file in the academic advising activities at UNITEN will also be presented and discussed.

Keywords: template file; academic advising; GPA calculator

1. Introduction

In Malaysia, students are using either SPM certificate, Matriculation certificate, or STPM certificate from a high school or diploma from a college as qualification to enter a university. They are usually facing several major challenges of the university academic life. The challenges are tough as they move from an education system where they were literally "fed" with knowledge into another education system where they must "seek" the knowledge with enough help from lecturers. They have personal responsibility in taking care of themselves where they are free to make choices on most aspects of their life, like whether to attend the class or otherwise, to do assignments, etc compared to their previous high school life. They themselves have to manage their time appropriately, do study plan, and must have appropriate study skill. Although they may have been bright stars in their respective high schools previously, they face fiercer competitions at the university. Lecturers may not press the students to do or finish the assignments as students now are treated like responsible adults. University transcripts become important to the students than anything else in shaping their future. Unlike in high schools, the university works are more difficult as they cover wider and harder topics. Choosing right friends is also more crucial than ever before as university friends circle can have tremendous influence on someone's attitude towards life, outlook, results and future achievement. In order to face these challenges systematically, they need guidance and advices from a person knowledgeable and experienced in the field.

Definitions of academic advising vary. Selected definitions from National Academic Advising Association (NACADA) of USA [1] are as follows. Academic advising is a systematic process based on a close student-advisor relationship intended to aid students in achieving educational, career, and personal goals through the use of their full potentials and the full range of institutional and community resources. Advising encourages students to think critically, seek out resources, and develop action steps. The desired result is that students will feel a sense of connection with the advisor and a sense of guidance, while realizing personal responsibility for exploring options and making decisions.

Although many individuals may assist the student in making decisions and accomplishing educational goals, the Academic Advisor (**AA**) can be regarded as a "formal authority" in university to assist the student in academic planning and other academic matters, as well as to monitor the student's progress. The advisor serves as a facilitator of communication, a coordinator of learning experiences through course and career planning and academic progress review, and an agent of referral to other campus agencies as necessary.

Academic advising is necessary to help the students face the academic challenges better and make informed and judicious decisions. The AA can be a role model for their students to excel in their studies, guiding them in study skills, time management and critical thinking as they get lesser

guidance from the family on such issues. Parents are usually not involved in student's courses, except for choosing the program, and students are left with absolute freedom to guide their education. Freedom without necessary guidance can lead to confusion and can be dangerous. Hence, academic advisor can fill the vacuum, to assist and guide the students during their academic endeavour.

1.1. Academic advising issues

According to [2], issues in academic advising can be divided into two broad categories: "working with students" and "advisor & system related". One of the resources helpful in advising students is GPA calculator. The ability to calculate GPA helps in academic advising in many ways, for example it helps the student to set a target for a semester GPA as well as preparing a proper study plan in order to achieve the target. There are GPA calculators available online for students to use [3]. In comparison to these GPA calculators, which may be developed according to academic regulation of a particular university, the template file for GPA calculator developed at UNITEN has more features packed into it for the purpose of academic advising.

2. Academic advising at UNITEN

This section highlights aspects of academic advising at UNITEN that are important and related to the development of the template file for GPA calculator.

2.1. Assignment and purpose of academic advisors

At UNITEN, every student has an AA who is normally assigned for the student throughout the entire period of study at the university. For an Engineering program for example, this will usually be four or five years depending on the program taken by a student. However, due to certain circumstances, like the AA left the university for doing job somewhere else or AA is taking leave for further study, a new AA will be assigned for the student.

Academic staff is assigned as the AA with the aims to provide advice or assistance in academic matters, to monitor progress of the advisees, and to serve as a guide by providing informed advice. The AA is usually required to meet with the students regularly to update on their academic progress and identify ways for further improvements, to sort out academic problems (if any), to discuss their study plans and targets, and also discuss any new developments and other academic matters. Students with CGPA less than 2.3 are given special attention and their academic activities are also monitored regularly [4]. In order to ensure that these students will graduate eventually, they are limited to take a certain number of credit hours during a semester.

2.2. Important matters from UNITEN academic regulation

Apart from functions described in previous section, the AA is also required to know and understand UNITEN academic regulation [5] clearly and in turn should be able to guide and help the students in these matters. The following points in the academic regulation are considered in the development of the template file for GPA calculator.

(a) One very important point in the academic regulation is about the requirement for graduation that requires a minimum CGPA of 2.0 for all subjects taken and passed, with a minimum CGPA of 2.0 also for "core" subjects taken during the program.
(b) Another important clause is that students will be dismissed from the program when they had obtained CGPA below 2.0 in two consecutive semesters (not including the special semester). Although students may be dismissed after obtaining CGPA below 2.0 in two consecutive semesters, they can appeal to Senate to be allowed to continue studying in the program. This is also mentioned in the academic regulation.
(c) Students entering a program at UNITEN after high schools are allowed by the academic regulation to replace a certain amount of credit hours they had taken during their earlier semesters, especially for subjects that they had obtained bad grades (i.e. grade lower than letter grade C). This is to compensate for their transition and adjustment from the school education system to the university education system, as students are usually taking time to adjust and adapt to the new system.
(d) Students are also permitted to get credit transfer from their previous institution of higher learning if they are not actually entering the university program directly from the high school. The number of credit hours transferred, in this case, is also taken into calculation for the total amount of credit hours allowed for replacement like fresh students from the high school.

All of the above important points and special considerations, as stated in the academic regulation, were taken into account when the template file was developed.

Flexible system at UNITEN where students are free to plan their study path and not necessarily following the "suggested path" makes academic advising more interesting and more challenging to the AA. The academic advisors should be more active in advising their students to make correct study plans based on the students' own capabilities and paces to absorb knowledge.

2.3. Calculation of GPA

The UNITEN academic regulation [5] also describes how semester GPA and CGPA are calculated. Core CGPA calculation is similar to CGPA calculation, but for selected subjects defined as "core" subjects. Both CGPA calculations take into account any subject replacement done by a student. Grade for a subject taken within allowable number of credit hours can only be replaced when the grade obtained during the second try is better than the previous grade. When replaced, grade from the first attempt is not counted in CGPA calculations.

The following are formulas used to calculate semester GPA, CGPA and Core CPA respectively.

(a) During a particular semester, let:

CHis as credit hours for a subject taken

GPis as grade point for letter grade obtained

Then, semester GPA (SemGPA) calculation is implemented using the following formula:

$$SemGPA = (\Sigma\ CHis \times GPis)/(\Sigma\ CHis) \quad -(1)$$

(b) During all semesters, let:

CHi as credit hours for a subject taken

GPi as grade point for letter grade obtained

CHir as credit hours for a replaced subject taken during first attempt

GPir as grade point for the replaced subject obtained during first attempt

Then, CGPA calculation is implemented using the following formula:

$$CGPA = (\Sigma\ CHi \times GPi - \Sigma\ CHir \times GPir) / (\Sigma\ CHi - \Sigma\ CHir) \quad -(2)$$

(c) During all semesters, let:

CHic as credit hours for a Core subject

GPic as grade point for the Core subject

CHirc as credit hours for a replaced Core subject taken during first attempt

GPirc as grade point for the replaced Core subject obtained during all first attempts.

Then, Core CGPA calculation is implemented using the following formula:

$$CoreCGPA = (\Sigma\ CHic \times GPic - \Sigma\ CHirc \times GPirc) / (\Sigma\ CHic - \Sigma\ CHirc) \quad -(3)$$

For all formulas, Σ is the summation of.

Formula (1), (2), and (3) are implemented within specific cells in the template file in order to get the required results from available raw data about Semester, Subjects taken, and Grades obtained for respective subjects in a particular semester.

3. Development of the template file for GPA calculator and its features

The original purpose of the development of **T**emplate **F**ile for **GPA C**alculator (**TF4GPAC**) was to assist the author (when he was a Head of Department of Electrical Engineering UNITEN) to make quick, correct, and concrete recommendations for appeals from dismissed students to continue their studies in the degree programs offered by the Department of Electrical Engineering UNITEN. Recommendations were made to the Senate whether to support or reject the appeals based on concrete results, analysis of students' performances, simulations performed and conclusion made from the available data entered into the TF4GPAC.

The first version of TF4GPAC was developed using Microsoft Excel in May 2002. After that, it was improved further and started to be used in academic advising activities, not only to provide recommendations for appeals from dismissed students but also as a tool by the AA to monitor the students' GPA and take early steps and intervention, when necessary, to prevent students from being dismissed at all. By detecting the GPA patterns during early stage, in particular for the students having CGPA hovering near 2.0, an AA is able to call, discuss and give correct advice to students to make correct study plan and take appropriate action to rectify the situation. The AA who had used and tested the earlier version of the TF4GPAC had also provided valuable feedbacks for further improving of the template file.

Hundreds of formulas, including formula (1), (2), and (3) above, are embedded in specific cells in the worksheet. Other than for calculating values, some formulas are used to check and ensure that correct data are entered into relevant cells in the template file. Checking is done, for example, to verify that correct and allowable letter grade (as specified in the academic regulation) are entered into Grade cells. Other checking is performed to make sure that credit hours and grade point for cells that are entered with subject codes and grades only will be available for the calculations. As a preventive measure for unintended alteration of formulas in important cells while entering the data, the AA is allowed to enter data in specific cells in the template file. These areas are clearly marked in the worksheet. Other areas are protected from the alteration. Cells in a worksheet are interlinked with other worksheets in the template file in order to provide summaries of important analysis in a compact and precise form.

Fig. 1 shows a screen shot of the latest version of the TF4GPAC (as at 24th June 2005). Compared to earlier versions, it looks slim and more attractive but the fact is that it packs more features. The AA is able to use the TF4GPAC easily because it provides clear instructions on the worksheet itself, in addition to a manual [6] provided for assisting the AA to use the TF4GPAC correctly and effectively.

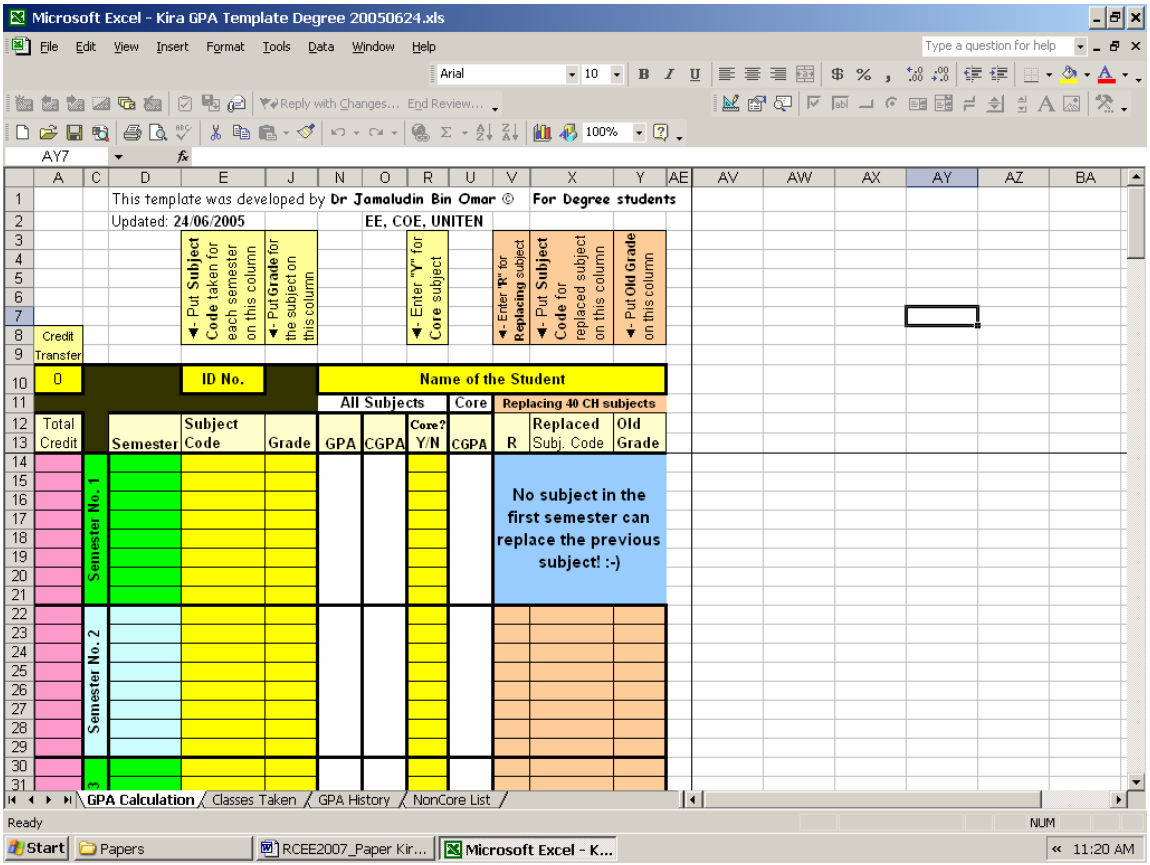


Fig. 1. Screen shot of the Template File for GPA Calculator.

The TF4GPAC consists of four separate worksheets called GPA Calculation, Classes Taken, GPA History, and NonCore List worksheets. Altogether the worksheets provide the following information: semester GPA, semester CGPA, Core CGPA, GPA history and trend, analysis of grades achieved by the student, and the range of the most probable CGPA to be obtained by the students when they graduate. With this information, the AA will be able to advice and guide their students appropriately. In addition, with the capability to simulate student performance in the following semester, the AA is able to predict the effect of students taking subjects in the following semesters, able to set the target GPA for the following semesters, and also able to plan whether students need to retake any subject taken within the limit of replaceable subject.

The TF4GPAC also handles special considerations and requirements allowed by the UNITEN academic regulation, such as taking into account any credit transfer given to the students, and replacing any subject taken within the limit of replaceable subject.

Another feature of the TF4GPAC is that the AA can directly and conveniently use data obtained from UNITEN Online Student Records (OSR) as input to the TF4GPAC. Calculations of the GPA implemented using hundreds of formulas embedded within specific cells in the template file are producing the same results as done by a similar modules developed for UNITEN OSR. This fact proved that two software developed independently are correctly producing the same result and can be trusted. Although similar (but with many separate) modules are available from the OSR for the AA to use for academic advising purposes, the TF4GPAC packs together all important and necessary data (thus, information) in a single file plus adding the analysis of grades (which is at the moment lacking from the OSR) and the capability of doing simulation to it.

Latest developments of the TF4GPAC made it particularly suitable to be used in academic advising activities. Academic advisors at UNITEN now are able to monitor and guide their advisees doing proper study plan, not only to maintain their GPAs slightly above the minimum requirement for graduation but also to maintain their GPAs at any required level, such as to be always in the Dean's List (with minimum semester GPA of 3.5) for example. Academic advisors are able to simulate and set the required semester GPA to be achieved by the advisees, based on known and recorded information about the GPA histories and capabilities of the advisees.

By using the template file also and always updating it when new data becomes available at the end of every semester, the academic advisors have current status and information about the

performances of their advisees. This will help them assist their Head of Department faster and efficiently when a certain decision is to be made about their advisees, in particular when recommendations are to be made to interested parties.

To further help students making their own study plans, perhaps by "playing" with simulation capability of the TF4GPAC after entering the real data for their grades achievement, similar software is made available on the internet [7] for students to use. All features are available there except the capability to copy data from the OSR. For the student version, students must enter the required data manually.

4. *Case Studies*

During development and testing of the TF4GPAC, the author had used the TF4GPAC for monitoring GPAs for students under his academic advising. There is not much action taken for high achievers except to encourage them to strive harder in order to graduate with better CGPA or at least maintain the current level of CGPA.

However, the author had taken appropriate intervention actions in order to help "near the border" achievers who have CGPA hovering around 2.0 (which sometime went below 2.0) to breath over the threshold level again. When detected through information obtained from the template file, the author contacted the advisees through available channels. The AA at UNITEN has access to their students' information (such as postal address, email address, and telephone numbers) through the OSR. After successfully contacting the students, meeting was arranged with the advisees to explore available options for them to improve their performances, in particular to get CGPA and Core CGPA above 2.0, so that they can be qualified to graduate when the time comes. After that, they are encouraged to visit the advisor when and as required. The following are two case studies of two students under the author's academic advising.

4.1. Case Study 1

The author was assigned as the AA to this student in early 2003. He was formerly studying in Bachelor of Information Technology (BIT) program but decided to switch to Bachelor of Electrical and Electronics Engineering (BEEE) program. The student was having problem with his CGPA and Core CGPA at the end of Semester 2 Session 2002/3 where both were below 2.0, and keep having Core CGPA below 2.0 since then. After Semester 2 Session 2002/3, his CGPA was between 2.0 to 2.1 until Semester 1 Session 2004/5 when it dipped slightly below 2.0 again. Refer to Fig. 2.

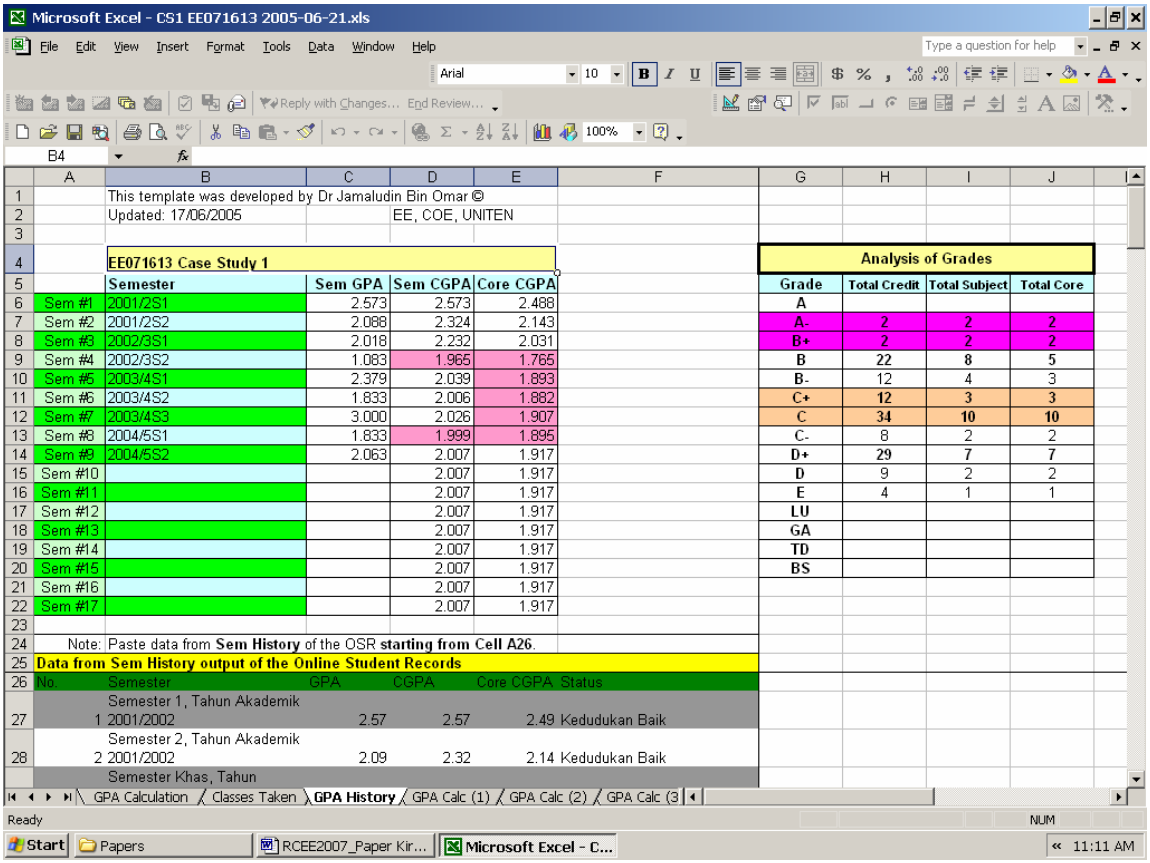
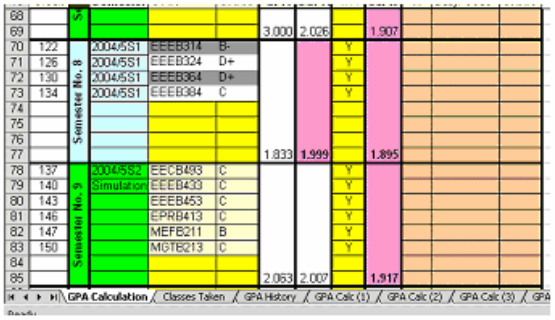


Fig. 2. GPA History of the student with simulation for Semester 2 Session 2004/5.

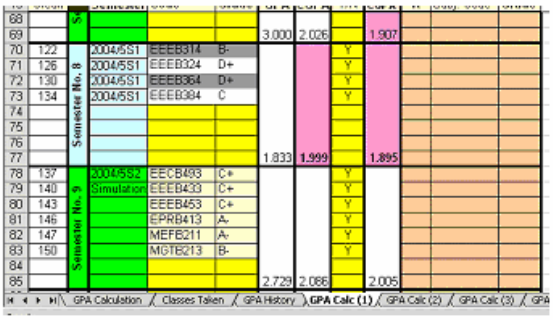
With active implementation of academic advising for the purpose of helping students with CGPA below 2.3 at the College of Engineering UNITEN [4] starting from Semester 1 Session 2004/5 the student was called to meet the author in July 2004. At that time, his CGPA was 2.03, his Core CGPA was 1.91, and he had already registered 4 "tough" engineering subjects with 16 credit hours and the author could not advice him to change subjects or explore other options. The author suggested that the student study harder in order to keep his CGPA above 2.0 by at least scoring grade C for all the subjects that he had taken and later try to increase his Core CGPA in the following semester. A copy of TF4GPAC for student was also given to him to use. Unfortunately he did not manage to score semester GPA of at least 2.0 but he managed to get only 1.83 instead, hence his CGPA dipped slightly below 2.0 (i.e. 1.999 to be more accurate) while his Core CGPA became 1.895.

During the following Semester 2, the author initially thought to suggest that the student repeat and replace two mathematics subjects which he had taken within allowable limits of replaceable credit hours and obtained grade D+ and D respectively. But after checking through his past performances with mathematics subjects, it was found that his achievement with mathematics subjects was mostly with these two grades. He suggested taking the remaining subjects in the program and the author proposed that he should take at least one non-engineering subject. Using simulation capability of the TF4GPAC, he must at least obtain semester GPA of 2.06 in order to get CGPA above 2.0 again, as shown in Fig. 3(a). Simulation was also done to explore the possibility of him getting out of Core CGPA problem also. For this he was required to study harder and push himself to the limit, in order to obtain semester GPA of 2.73, as shown in Fig. 3(b). We agreed that he had to study harder in order to achieve that target. However, he managed to score the semester GPA of 2.48 and improved his CGPA to 2.05, while his Core CGPA was improved to 1.97, Fig. 3(c). The author then revisited his GPA History, Figure 2, and found that the best semester GPA that he had obtained throughout his study during normal semester is 2.57. The author satisfied that he indeed had pushed himself to the limit.

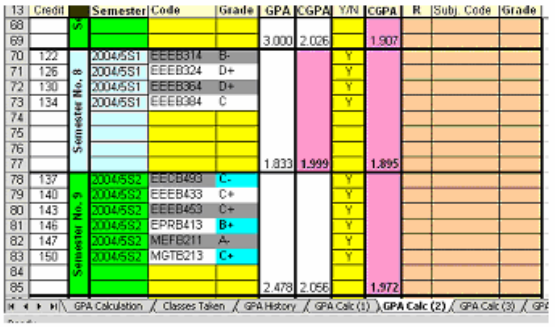
Although he was still in trouble with his Core CGPA, with another simulation by putting achievable grades based on his previous achievements into the TF4GPAC we predicted that he would be able to graduate at the end of Semester 1 Session 2005/6 if he managed to score a semester GPA of at least 2.25, as shown in Fig. 3(d). Indeed, he did graduate at the end of Semester 1 Session 2005/6 with CGPA of 2.153 and Core CGPA of 2.086 after he pushed himself harder and managed to obtain the semester GPA of 2.957, which is also the highest semester GPA during normal semester he ever obtained during his study in BEEE program, as shown in Fig. 4.



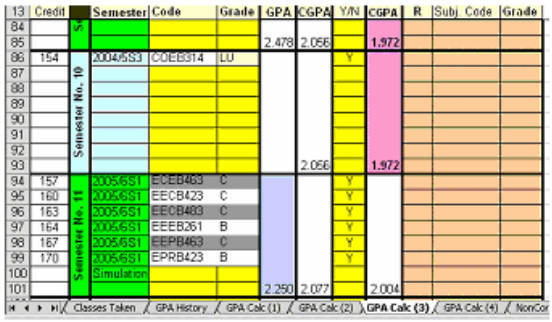
(a) Simulation for getting CGPA over 2.0



(b) Simulation for getting both CGPA and Core CGPA above 2.0

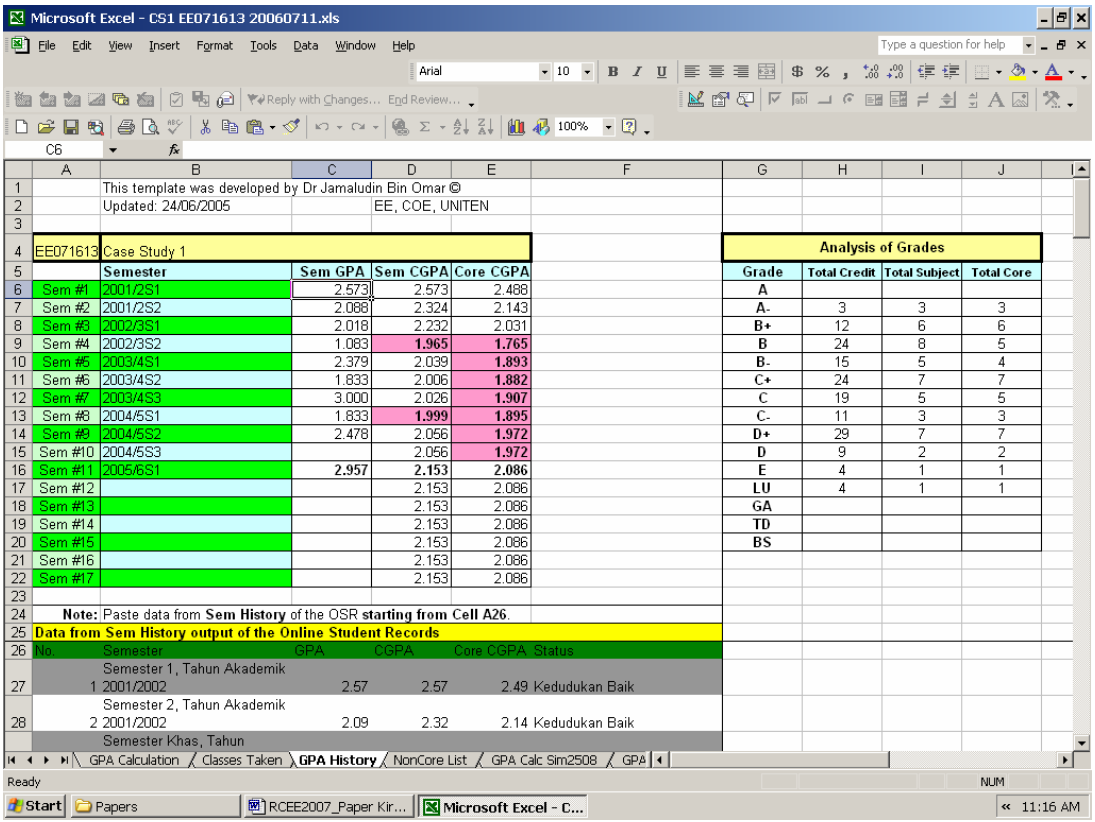


(c) The actual performace for Semester 2 2004/5



(d) Simulation for Semester 1 Session 2005/6

Fig. 3. Simulations done and comparison with actual performance.



Microsoft Excel - CS1 EE071613 20060711.xls

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Updated: 24/06/2005
EE, COE, UNITEN

EE071613 Case Study 1

Semester	Sem GPA	Sem CGPA	Core CGPA
Sem #1	2001/2S1	2.573	2.573	2.488
Sem #2	2001/2S2	2.088	2.324	2.143
Sem #3	2002/3S1	2.018	2.232	2.031
Sem #4	2002/3S2	1.083	**1.965**	**1.765**
Sem #5	2003/4S1	2.379	2.039	**1.893**
Sem #6	2003/4S2	1.833	2.006	**1.882**
Sem #7	2003/4S3	3.000	2.026	**1.907**
Sem #8	2004/5S1	1.833	**1.999**	**1.895**
Sem #9	2004/5S2	2.478	2.056	**1.972**
Sem #10	2004/5S3		2.056	**1.972**
Sem #11	2005/6S1	**2.957**	**2.153**	**2.086**
Sem #12			2.153	2.086
Sem #13			2.153	2.086
Sem #14			2.153	2.086
Sem #15			2.153	2.086
Sem #16			2.153	2.086
Sem #17			2.153	2.086

Note: Paste data from **Sem History** of the OSR **starting from Cell A26.**

Data from Sem History output of the Online Student Records

No.	Semester	GPA	CGPA	Core CGPA	Status
1	Semester 1, Tahun Akademik 2001/2002	2.57	2.57	2.49	Kedudukan Baik
2	Semester 2, Tahun Akademik 2001/2002	2.09	2.32	2.14	Kedudukan Baik
	Semester Khas, Tahun				

Analysis of Grades

Grade	Total Credit	Total Subject	Total Core
A			
A-	3	3	3
B+	12	6	6
B	24	8	5
B-	15	5	4
C+	24	7	7
C	19	5	5
C-	11	3	3
D+	29	7	7
D	9	2	2
E	4	1	1
LU	4	1	1
GA			
TD			
BS			

Fig. 4. GPA History of the student who finally graduate at the end of Semester 1 Session 2005/6.

4.2. Case Study 2

This is a case of transition and adaptation from high school system into the university system. This student entered Bachelor of Electrical Power Engineering (BEPE) 5-year program using SPM qualification starting from Semester 1 Session 2003/4. The author had never met this student during his first 2 semesters at UNITEN, although the author was assigned as his AA. While testing the TF4GPAC by using data for advisees in his AA list, the author noticed that the student was already in trouble because his CGPA and Core CGPA in first 2 consecutive semesters at UNITEN were below 2.0 and he was already dismissed from the university.

Using available information about the student from the OSR, the author had written a letter to the student asking him to meet the author to discuss about his situation. That time was sometime before next Semester 1 Session 2004/5 begins. The student came and met the author, for the first time as academic advisor and advisee. During the discussion, the author first suggested to the student to appeal from being dismissed. We also discussed about other possibilities for the student to amend and improve his CGPA during the next semester in case he succeeded in his appeal. The first strategy was for him to score a CGPA above 2.0 in the following semester. Later, the student could try to improve the CGPA further. Also, the author had given him the student version of the TF4GPAC to use and plan his study appropriately.

During the meeting also, the student was reminded about academic advising and its purpose to help the student. He was also asked to meet the author anytime he needed to discuss about his academic progress at the university. He was also asked to study hard from that time in order to achieve his ambition.

The student succeeded in his appeal to continue the study and also managed to pull through in Semester 1 Session 2004/5. By getting a semester GPA of 3.248, his CGPA and Core CGPA were over 2.0 and he could continue his study.

We met again before subject registration period for Semester 2 Session 2004/5 was over. After checking through all subjects taken during previous three semesters, where their grades were still replaceable (according to UNITEN academic regulation), the author suggested that the student retook a subject (EEEB214) that he had taken in the first semester where he had obtained grade D. With this, CGPA of the student can be improved considerably if he can score the best grade possible. As suggested, the student retook the subject during Semester 2 Session 2004/5 together with new subjects. He managed to score grade A-, and together with other new subjects he obtained CGPA and Core CGPA of over 2.6. He managed to maintain later on

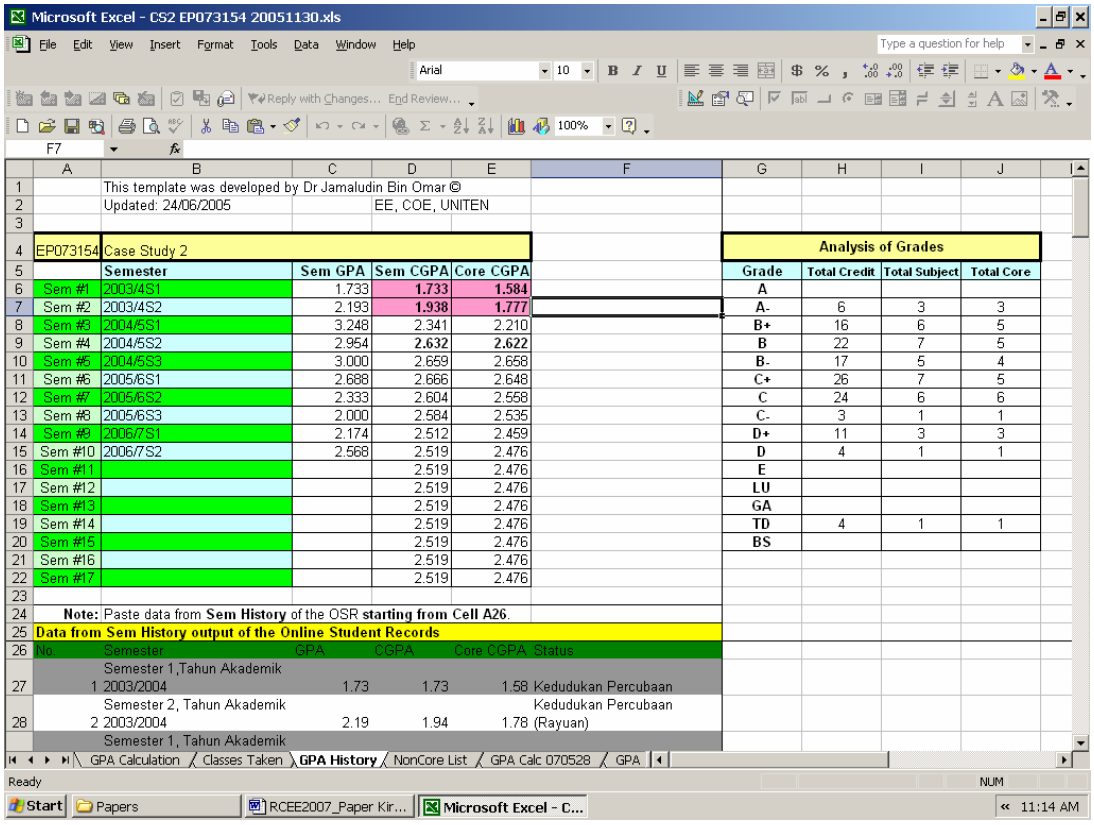

Fig. 5. GPA History of the student for Case Study 2 (the student is still studying).

until Semester 2 Session 2006/7 the CGPA over 2.5, see Fig. 5. We met quite frequently to discuss about his academic progress during the semester after that.

5. Conclusion

The TF4GPAC is a very useful tool that has contributed to a more interesting and lively academic advising activities at UNITEN. Coupled with student development activities [4], active and correct academic advising by academic advisors will help reduced the number of students failing the program in the future. Early intervention by AA by suggesting a more realistic study plan to the advisees, as a result of early detection from available data and up-to-date analysis in the TF4GPAC, will make this possible.

It was proven with case studies that TF4GPAC and correct academic advising can contribute to the successful completion of a degree program in Engineering by student having CGPA near the border of passing or failing the program.

Acknowledgements

The development of TF4GPAC and its use in the academic advising activities is a result of constant supports from the College of Engineering's staffs, constant feedback and suggestions for improvement from the academic advisors, as well as students in the academic advising list of the author who were testing the student's version of the template file. Also, the Registrar's Office had played a very important role in making the OSR to produce output that is compatible and easily imported into the template file.

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Implementing Online Assessment in Electronic Engineering Course for Undergraduate Students in UTHM

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Abstract

A new approach of academic assessment has been implemented in electronic engineering course in Universiti Tun Hussein Onn Malaysia (UTHM). The online assessment method is used as an alternative to conventional assessment method used for years. Unlike the conventional approach, the online assessment does not require the students and lecturer to be face-to-face during the assessment and it also gives more flexibility for students to choose the assessment time. Given the ease in implementing this type of assessment, it still maintains high quality of questions given to students. At the end of the assessment period, it does attain the objective of the assessment and it also reflects the understanding of students towards the intended topic of the assessment. We conclude that the implementation of this assessment approach is a success to gauge the performance of students and it also can serve as an effective complement to conventional assessment approach.

Keywords: online assessment; alternative assessment approach

1. Introduction

The concept of e-learning has been implemented for years and it is common to see the instructional materials are delivered through this approach especially in higher education level. The system itself does not intended to replace the conventional way to deliver the subject content to students but to enhance and vary the way the material is presented. Nevertheless, many academicians still shy away from using online system as an assessment tool.

Online system is often seen to compromise the standard of question in an assessment. This is due to the perception that online system will only tests the must-know material. But the fact is that online can actually match, if not better, the standard of paper assessment [1]. The same approach does provide an effective measurement of the students' practical skills by comparing student performance in a variety of scenarios [2].

Besides, the online assessment could provide an effective formative assessment tool for students on regular basis and permitting them to evaluate their knowledge independently throughout the semester calendar [3]. The online system also has been reported could help students to study more consistently and improve the study habit in their preparation [4], [5], [6]. It shows that this system has positive effect towards students to gain better grades in succeeding assessment. The same scenario on students' performance is also seen with the aid of self-directed assessment modules [7].

On the other hand, the online system offers more flexibility to both lecturers and students. Students have flexible means in attempting the assessment and receiving feedback of the assessment whereas the lecturer has the option to automatically grading the assessment [1], [8]. Thus, this is an obvious advantage of online assessment over the paper assessment.

In order to maintain the quality of the online assessment, a benchmarking procedure on this type of assessment has been proposed and at the same time, the benchmark should be transparent to students in terms of the behaviour and expectations [9]. In this paper, we present our first attempt in implementing the online assessment on the first year students in electronic engineering course and followed by the analysis on the result of the assessment.

2. Blackboard as an Assessment Tool

In case of UTHM, *Blackboard Learning System (Blackboard)* has been chosen as the platform to establish the e-learning system. It is a common sight the lecturer utilizing *Blackboard* as part of teaching and learning activity throughout the semester. However, its capability to assess the students is not fully utilise. The lecturers tend to limit *Blackboard* as a platform to present the subject content only.

Therefore, we decided to do the assessment via the *Blackboard* and to see the effectiveness on the

student performance. Fig. 1 shows the front page of *Blackboard* after user has login to the system.

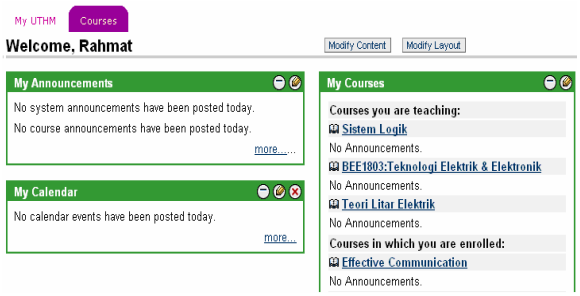


Fig. 1. Front page of Blackboard system.

Blackboard provides a tool for lecturer as a mean to appraise the performance of students from time to time. The assessment can be made in objective or subjective questions. Multiple-choice questions, true/false and fill in the blank are examples of objective questions whereas essay and structured questions, are examples of subjective questions. Obviously, lecturer can choose the type of questions that is suit to their subject content. The process is almost the same as preparing normal assessment. The following is a general steps on how a lecturer prepares an assessment in *Blackboard*:

1. : Create a pool of questions that will be used in an assessment. Decide the type of question.
2. : Each question must be accompanied by its correct answer.
3. : The question pool is considered complete if the number of questions is sufficient enough for the particular evaluation.
4. : Create an assessment and import the question from the pool created earlier.
5. : Assessment must be configured such as the duration, none of questions and what the system should display to the user at the end of assessment.
6. : Test marks will be accumulated and arranged in Grade book in the system. Lecturer may reset any particular score and allow for retest.

3. Developing an Assessment

The process of developing an assessment starts with creating a pool of questions in the system. There are several type of questions can be made such multiple choice questions, essays and fill in the blank. We decided to prepare a pool of questions for an online quiz for the electronic engineering students. This quiz covers the fundamental topic in electronic circuit and circuit analysis. We chose the multiple choice question for the quiz since the students is seldom assessed with this type of question in undergraduate level. However, the challenge is to create a simple, comprehensive question and yet the options of the answer should look fuzzy to the students. Fig. 2 shows the capture in the first step to create the pool of questions that starts with writing the instructions to the students before attempting the quiz.

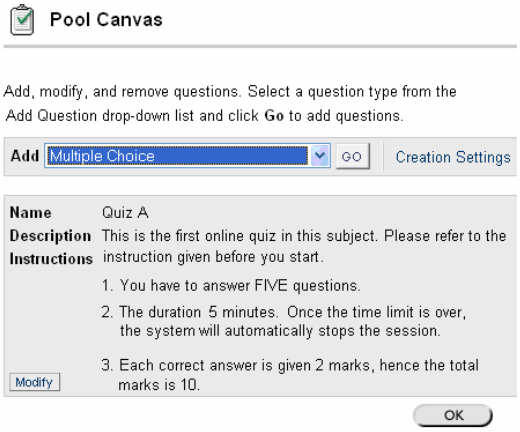


Fig. 2. Creating a pool of questions.

The process to build the pool consumes a lot of time since it determines the level of questions that will appear in the assessment. Depending on the weight of the assessment, the level of difficulties will be changed accordingly. In this case, we managed to develop a total of 200 questions in the pool. Since this is our first attempt to implement an online quiz, thus the result of this quiz will be used as a benchmark for online assessment in the future in term of its effectiveness and response of the students.

Fig. 3 shows some of the questions created in the pool. Each of the questions is followed by the correct answer that will be used by the system to mark the answer of students. Besides, each of the questions can be edited and removed as well

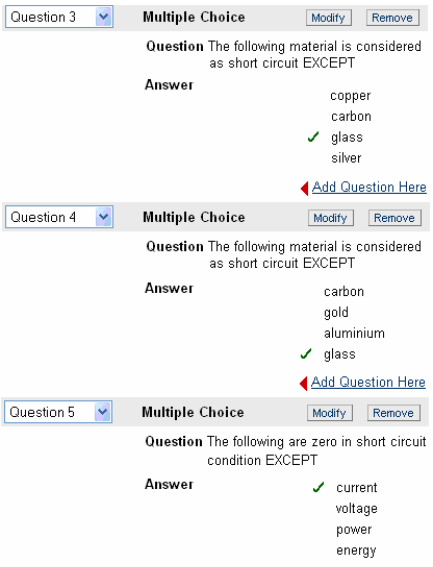


Fig. 3. An example of questions created in a pool.

Finally, we saved the question pool in the *Pool Manager* in order to complete the process of creating the pool. Fig. 4 shows the capture when the question pool has been saved in the system. Next, all of these questions are ready to be deployed in the intended quiz.

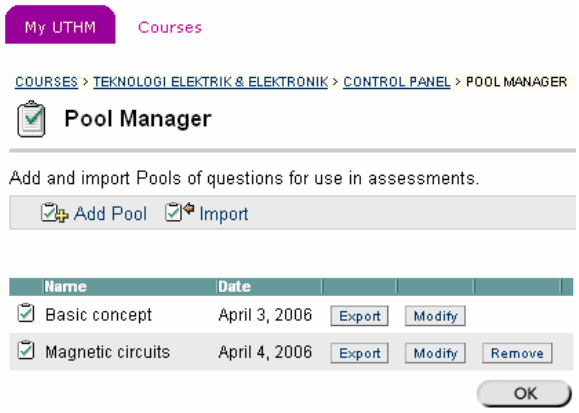


Fig. 4. Question pool saved in the system.

Once the pool of question is ready, the next step is to create an assessment in *Test Manager*. Creating an assessment is very simple once a question pool has been developed and saved in the *Pool Manager*. In this case, we have created the quiz in the *Test Manager*. Fig. 5 shows the capture of the quiz that has been created in the system. Next, we need to configure the quiz.

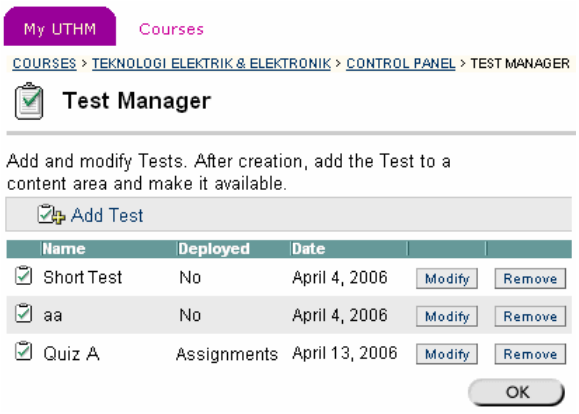


Fig. 5. Creating intended assessment.

The assessment configuration will determine the length of the assessment, number of questions and also the marks given for each correct answer. We decided that each student has to answer five questions in five minutes and each correct will be given two marks. The system will pick five different questions in random each time a student log into the system. Fig. 6 shows the capture of configuration of this assessment.

Since there are about 200 questions in the pool, this configuration will give about 40 different set of questions to the students. Thus, we expect that each student will have different set of questions although a group of them log into the system simultaneously. This is important since they are not invigilated during the quiz. The students have the flexibility to do the quiz at their own time but it must be done within 24 hours after the quiz has been uploaded into the system.

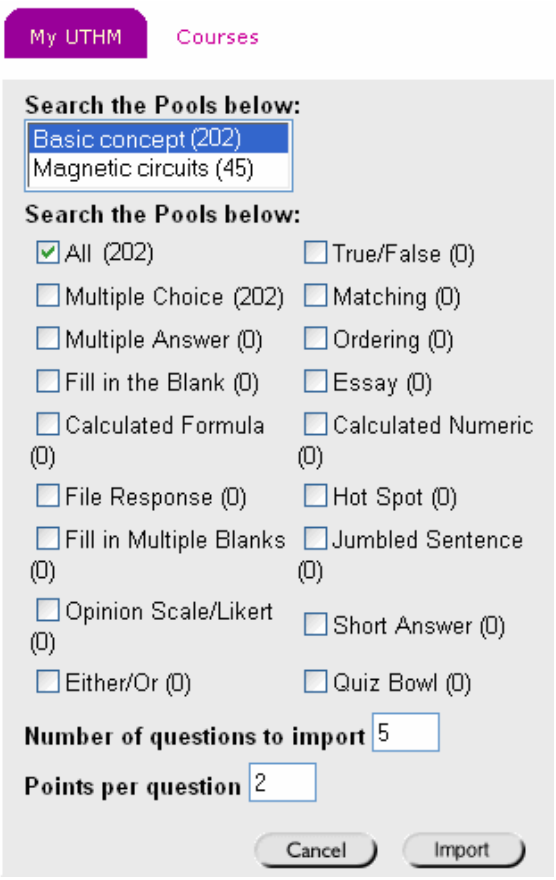


Fig. 6. Configuration of the quiz.

An obvious advantage of this online quiz is the flexibility in terms of time and place of the assessment. The students are free to do the assessment anytime within the time frame given and at any place as long as there is an Internet connection. Furthermore, the lecturers also have fewer burdens to mark the answer since the system will automatically do the marking task according to the uploaded correct answer. The student is able to view the result of the quiz upon completing the quiz as shown in Fig. 7.

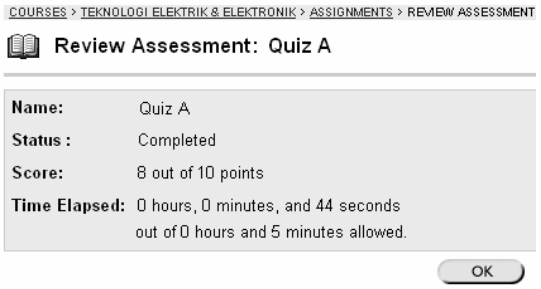
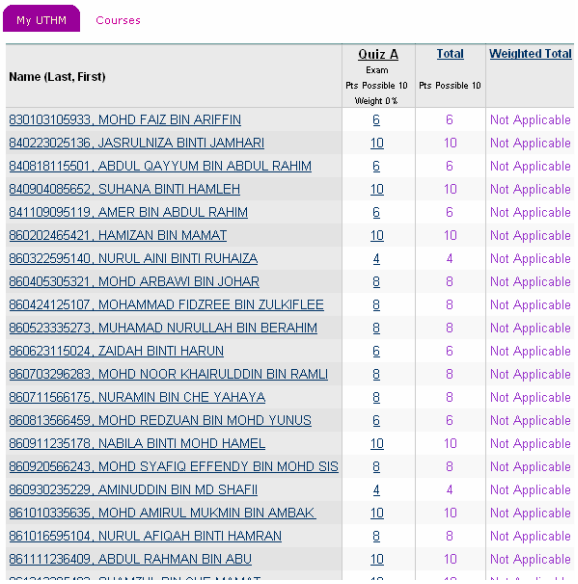


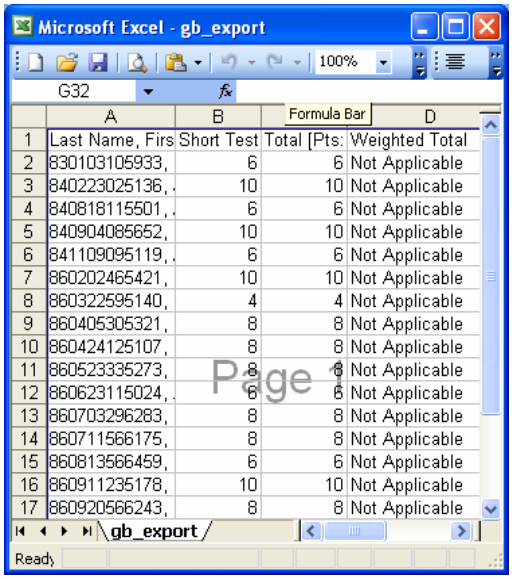
Fig. 7. Sample view upon completing the quiz.

After the 24-hour time frame is over, the quiz will be automatically hidden in the system and cannot be accessed by the students. The lecturer can view the result of all students in grade book as shown in Fig. 8. The marks of our students are then imported from the system in the form of Excel file as illustrated in Fig. 9.



Name (Last, First)	Quiz A Exam Pts Possible 10 Weight 0%	Total Pts Possible 10	Weighted Total
830103105933, MOHD FAIZ BIN ARIFFIN	6	6	Not Applicable
840223025136, JASRULNIZA BINTI JAMHARI	10	10	Not Applicable
840818115501, ABDUL QAYYUM BIN ABDUL RAHIM	6	6	Not Applicable
840904085652, SUHANA BINTI HAMLEH	10	10	Not Applicable
841109095119, AMER BIN ABDUL RAHIM	6	6	Not Applicable
860202465421, HAMIZAN BIN MAMAT	10	10	Not Applicable
860322595140, NURUL AINI BINTI RUHAIZA	4	4	Not Applicable
860405305321, MOHD ARBAWI BIN JOHAR	8	8	Not Applicable
860424125107, MOHAMMAD FIDZREE BIN ZULKIFLEE	8	8	Not Applicable
860523335273, MUHAMAD NURULLAH BIN BERAHIM	8	8	Not Applicable
860623115024, ZAIDAH BINTI HARUN	6	6	Not Applicable
860703296283, MOHD NOOR KHAIRULDDIN BIN RAMLI	8	8	Not Applicable
860711566175, NURAMIN BIN CHE YAHAYA	8	8	Not Applicable
860813566459, MOHD REDZUAN BIN MOHD YUNUS	6	6	Not Applicable
860911235178, NABILA BINTI MOHD HAMEL	10	10	Not Applicable
860920566243, MOHD SYAFIQ EFFENDY BIN MOHD SIS	8	8	Not Applicable
860930235229, AMINUDDIN BIN MD SHAFII	4	4	Not Applicable
861010335635, MOHD AMIRUL MUKMIN BIN AMBAK	10	10	Not Applicable
861016595104, NURUL AFIQAH BINTI HAMRAN	8	8	Not Applicable
861111236409, ABDUL RAHMAN BIN ABU	10	10	Not Applicable

Fig. 8. Result saved in the grade book.



	A	B	D
1	Last Name, Firs	Short Test	Total [Pts: Weighted Total
2	830103105933,	6	6 Not Applicable
3	840223025136,	10	10 Not Applicable
4	840818115501,	6	6 Not Applicable
5	840904085652,	10	10 Not Applicable
6	841109095119,	6	6 Not Applicable
7	860202465421,	10	10 Not Applicable
8	860322595140,	4	4 Not Applicable
9	860405305321,	8	8 Not Applicable
10	860424125107,	8	8 Not Applicable
11	860523335273,	8	8 Not Applicable
12	860623115024,	6	6 Not Applicable
13	860703296283,	8	8 Not Applicable
14	860711566175,	8	8 Not Applicable
15	860813566459,	6	6 Not Applicable
16	860911235178,	10	10 Not Applicable
17	860920566243,	8	8 Not Applicable

Fig. 9. Grade book imported in form of Excel file format.

We are able check the performance of each of our students as shown in Fig. 10 just like in the normal assessment. Each of questions answered by the students is clearly marked and the correct answer is given as well. As far as the online assessment is concerned, the process is already completed. The lecturer may prepare the questions for the next assessment.

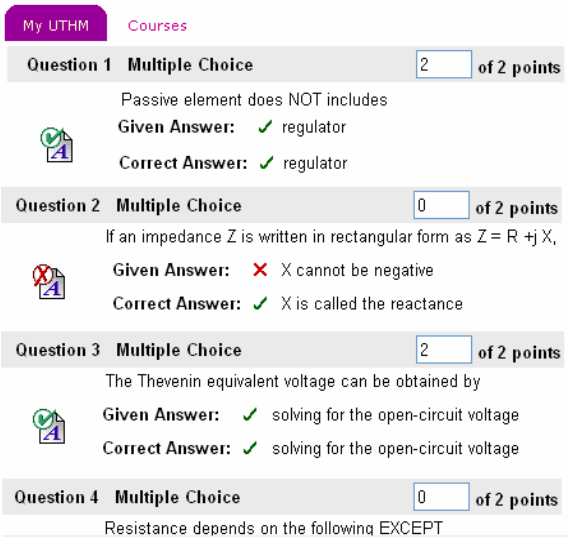


Fig. 10. A sample view of student performance in the quiz.

4. Observation and Discussion

The observation of this quiz can be made on several points; which are the difficulties of the given questions, the ability of the system to pick question from the pool randomly and the overall result of the students.

In general, the difficulty level of the online quiz compared to normal assessment is almost similar. The range of difficulty lies within the level 1 to 4 of the Taxonomy Bloom. Even though the questions are in form of multiple choices, it does not necessarily reflect the questions are easy and straightforward as assumed by most of people. In fact, the multiple choice question is one of the toughest types of question in determining the correct answer provided the choice of answer is very close. However, due to time constraint in preparing the question pool, about two third of total questions have low level of difficulty. The questions are also lack of review from other lecturers and hence the suitability and the structure of the questions could be improved in the future assessment. The quiz can be improved further by adding more questions with higher level of difficulty and hence make it more challenging to the students. However, it does attain the objective of the assessment to test the understanding of students in the fundamental of this subject since the given questions cover all the key topics.

After reviewing the performance of each student, it is apparent that some questions are frequently picked by the system. This causes many students got at least one same questions in their 5-question quiz. This problem could be due to the size of the question pool is not large enough to enable the system to provide totally different set of questions for each student. However, since the majority of students are attempting the quiz very quickly, they could not memorise the exact questions that they have

attempted. Nevertheless, this flaw could be improved by providing a large number of questions in the pool in order for the system to provide a different set of question from one student to another.

A total of 140 students have taken this quiz as part of their assessment. The result shows that the majority of them, about 65%, managed to get at least 80% of total marks. Another 25 % managed to score 60% and the rest of them only afford to have less than 60% of the total marks. Fig. 11 shows the plot of the result from this online assessment. This result is compared to another quiz that had been done in class a few weeks before. The online quiz result perform much better compared to result of the quiz especially in the group of getting marks in the range of 6 – 10. However, this online result could be affected by early preparation of students since they had been notified a week before the online quiz. The students also might have discussed among themselves during the quiz.

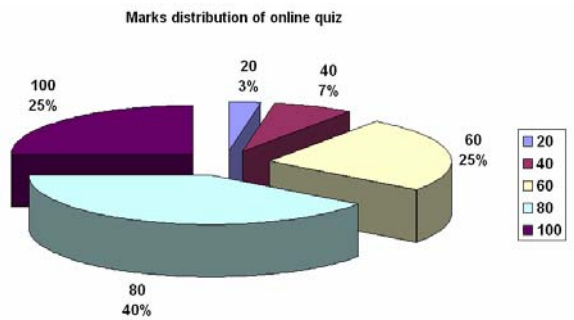


Fig. 11. Marks distribution of the quiz.

5. Conclusion

The online assessments in this paper prove that it can be used as an alternative channel to assess the performance of students. It does not intended to replace the conventional approach that had been used for decades but it adds the variety of ways to hold an assessment. The question in this online quiz shows some flaws in terms of the implementation and the selection of questions but it becomes as the basis to improve the method of preparing an online assessment in the future. Apart from the level of quality of questions given, online assessment is actually has successfully performed well to assess the performance of students. It also gave flexibility to students in terms of the assessment time and at the same time it has reduced the burden of the lecturer to mark the assessment. Another advantage of the online assessment is that the lecturer is able to reconfigure another assessment provided that the question pool is already created in the system. In general, the online assessment is successfully managed to gauge the performance of students and it helps lecturer to vary the method to hold an assessment.

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Development of N-Well CMOS Process in a University Microfabrication Laboratory

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Abstract

This paper describes the development of N-Well CMOS process that caters to the need of microfabrication course in a university microfabrication laboratory. The fabrication of standard CMOS transistors in a university laboratory is difficult because the overall process is complicated and time consuming. An approach is being developed in the Micro Fabrication Laboratory at UniMAP that allows the fabrication of CMOS transistors similar to the one in a semiconductor industry cleanroom. A total of 50 process steps have been designed and six masks are created for the fabrication of N-Well CMOS. The six masks namely N-Well, N+ diffusion, P+ diffusion, Gate, Contact, and Metal. All fabrication processes of the N-Well CMOS would take place in the UniMAP's Micro Fabrication Laboratory. This CMOS development allows the undergraduates of a microfabrication course to learn and perform CMOS fabrication technology. The N-Well CMOS process has much simpler process steps, shorter processing time, inexpensive and safe-friendly.

Keywords: N-Well CMOS; microfabrication; cleanroom

1. Introduction

Complementary metal oxide semiconductor (CMOS) is the standard building block in integrated circuit (IC) technology. A standard CMOS process consists of so many fabrication steps that are really complicated to understand and very time constraint to perform in a university laboratory as the process requires high quality environment, precise expensive equipments setup, various materials involved, and the most important part of all is the knowledge and expertise to understand the whole CMOS technology. Despite the complexity, it is necessary to master the knowledge of the IC making steps. Therefore, an approach is being developed in the Micro Fabrication Laboratory [1] at UniMAP to provide simpler understanding in the CMOS fabrication process but without neglecting important points [2]. This paper is about to describe the development of N-Well CMOS process in a university microfabrication laboratory.

Fig. 1 shows the simpler process flow of N-Well CMOS. The developed N-Well CMOS process is based on the processing of four inch p-type silicon wafer. The process has six photolithography steps and there are the formation of N-Well, n-type transistor source and drain, p-type transistor source and drain, gate oxide, contact, and metal wiring. The process will features single level metallization that also includes metal gate formation and exhibits non-local oxidation of silicon (LOCOS) isolation region. In standard CMOS process, LOCOS serves as isolation between two transistors. In this case, a thick field oxide grown by wet oxidation replaces the LOCOS. Another feature is the use of solid source as dopant deposition into the wafer to form n-type and p-type sources and drains. Besides safer and intoxicating, the solid source is suitable to handle in the university laboratory level. An N-Well CMOS transistor will have the basic structure as shown in Fig. 2.

The process besides being easier to perform in a university microfabrication laboratory, the process itself is much simpler to understand as oppose to standard derivation of CMOS process. With such advantage, the CMOS can be fabricated in short time thus saving cost. Besides producing CMOS transistors, the university is also producing expertise in the semiconductor device fabrication and characterization as well.

2. Methodology

The fabrication of N-Well CMOS starts with the mask generation. Mask layouts of N-Well CMOS are designed using computer aided design (CAD) software. A total of six mask layouts have been designed and there are namely N-Well, N+ diffusion,

P+ diffusion, Gate, Contact, and Metal [3]. These mask files are then converted into Gerber file format so that it could be plotted onto high definition films. Once the films are ready, they are used in the photolithography process to transfer the patterns onto the layers of semiconductors. Fig. 3 shows the complete set of mask designs for N-Well CMOS transistor.

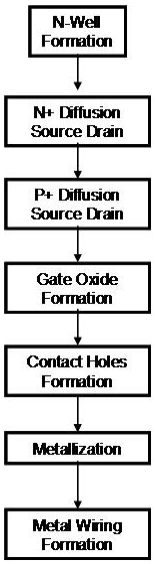


Fig. 1. Simplified N-Well CMOS Process Flow.

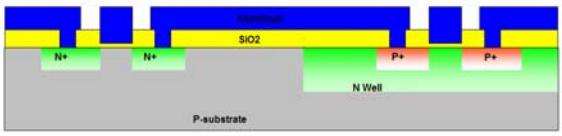


Fig. 2. Final Cross Section of N-Well CMOS.

The second phase is the real fabrication processes of N-Well CMOS. The fabrication procedure starts with a starting material of four inch <100> boron doped p-type silicon wafer [4-9]. A thick silicon oxide film is grown onto the silicon wafer under wet oxidation process in a high temperature wet oxidation furnace. The thick oxide film protects the silicon surface from diffusion of phosphorus onto unwanted areas.

The first mask film, N-Well is transferred onto the layer of deposited negative photoresist on top of the silicon wafer in the photolithography process. The mask is exposed under ultra violet (UV) light using the mask aligner. Once exposed, the photoresist is developed in the developer solution. The developed resist is then observed under the optical microscope to check for uniformity and critical dimension. The thick oxide film is later removed using buffered oxide solution to expose the silicon surface.

The formation of N-Well begins with the deposition of phosphorus using the solid source techniques [10]. The diffusion process of phosphorus takes place in the high temperature diffusion furnace where the phosphorus atoms are diffused deeper into the silicon substrate to create N-type well to support the P-type transistor. Once the diffusion is complete, the oxide film is etched away using buffered oxide solution.

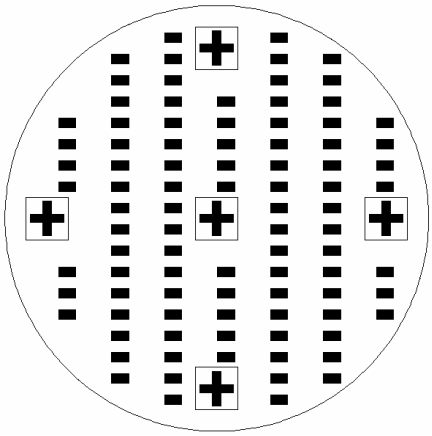
The diffusion process to create the source and drain regions of N-type and P-type transistors repeats the oxidation-photolithography-diffusion process steps [11]. Thick oxide film is grown onto silicon substrate and the second and the third mask films, N+ diffusion and P+ diffusion, are transferred onto the photoresist. Once the photoresist are developed and the thick oxide film are etched, respective phosphorus and boron atoms are diffused onto the exposed silicon surfaces to create N-type source drain and P-type source drain. Once completing all diffusion processes, a new silicon oxide named as the field oxide is grown back onto silicon substrate to serve as isolation region later on.

The next step is to form the gate region. The fourth mask film, Gate, is transferred onto the photoresist during the photolithography process. After development, the exposed field oxide is etched away to open and expose a small window on silicon substrate. An oxidation process under the presence of dry oxygen is performed onto the silicon substrate to grow a very thin oxide film.

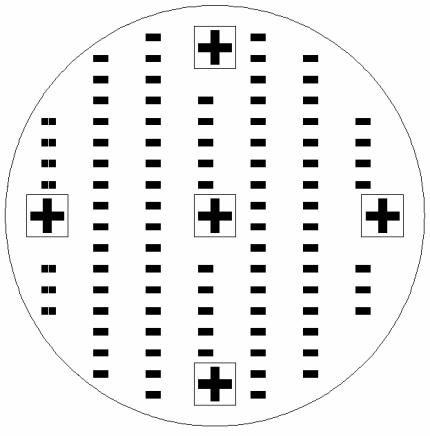
The fifth mask film, Contact, is used to make holes in the field oxide. These holes are to contact between the source and drain regions of the transistors with the aluminium. Before the last photolithography steps, metallization is performed. Aluminium is the metal used for wiring connectivity in this CMOS process. Aluminium is deposited onto the silicon substrate by evaporation technique. The metallization process is done inside the physical vapour deposition (PVD) module. The final photolithography step uses the sixth mask film, Metal, to define the metal gate and interconnectivity. The last step completes the N-Well CMOS fabrication processes. Fig. 4 depicts the major cross section in the N-Well CMOS process explained earlier in the paragraph.

3. Materials and equipments

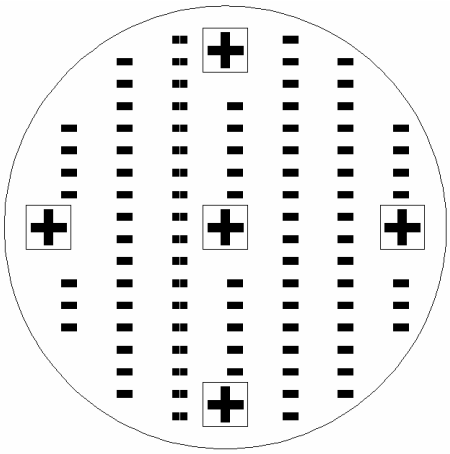
The Micro Fabrication Laboratory at UniMAP has well equipped fabrication equipments and materials to perform semiconductor device fabrication and characterization. The laboratory has successfully fabricated N-type and P-type MOSFETs. Materials used to fabricate the N-Well CMOS are silicon wafers, photoresists, acetone, developer solution, de-ionized (DI) water, buffered oxide etch (BOE) solution, aluminium paper, and aluminium etchant solution. Most of the materials will be used during photolithography and wet etching processes [12].



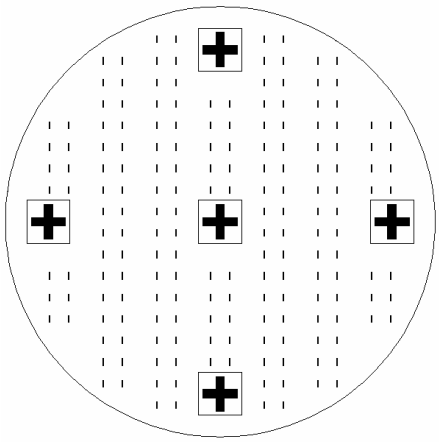
Mask 1: N-Well



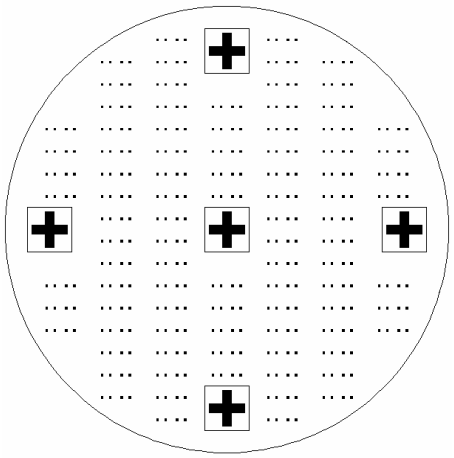
Mask 2: N+ Diffusion



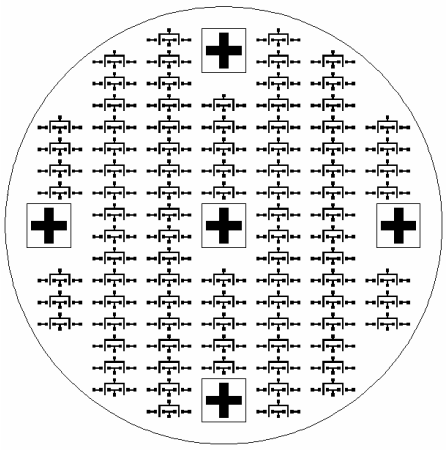
Mask 3: P+ Diffusion



Mask 4: Gate



Mask 5: Contact



Mask 6: Metal

Fig. 3. Mask Designs for N-Well CMOS.

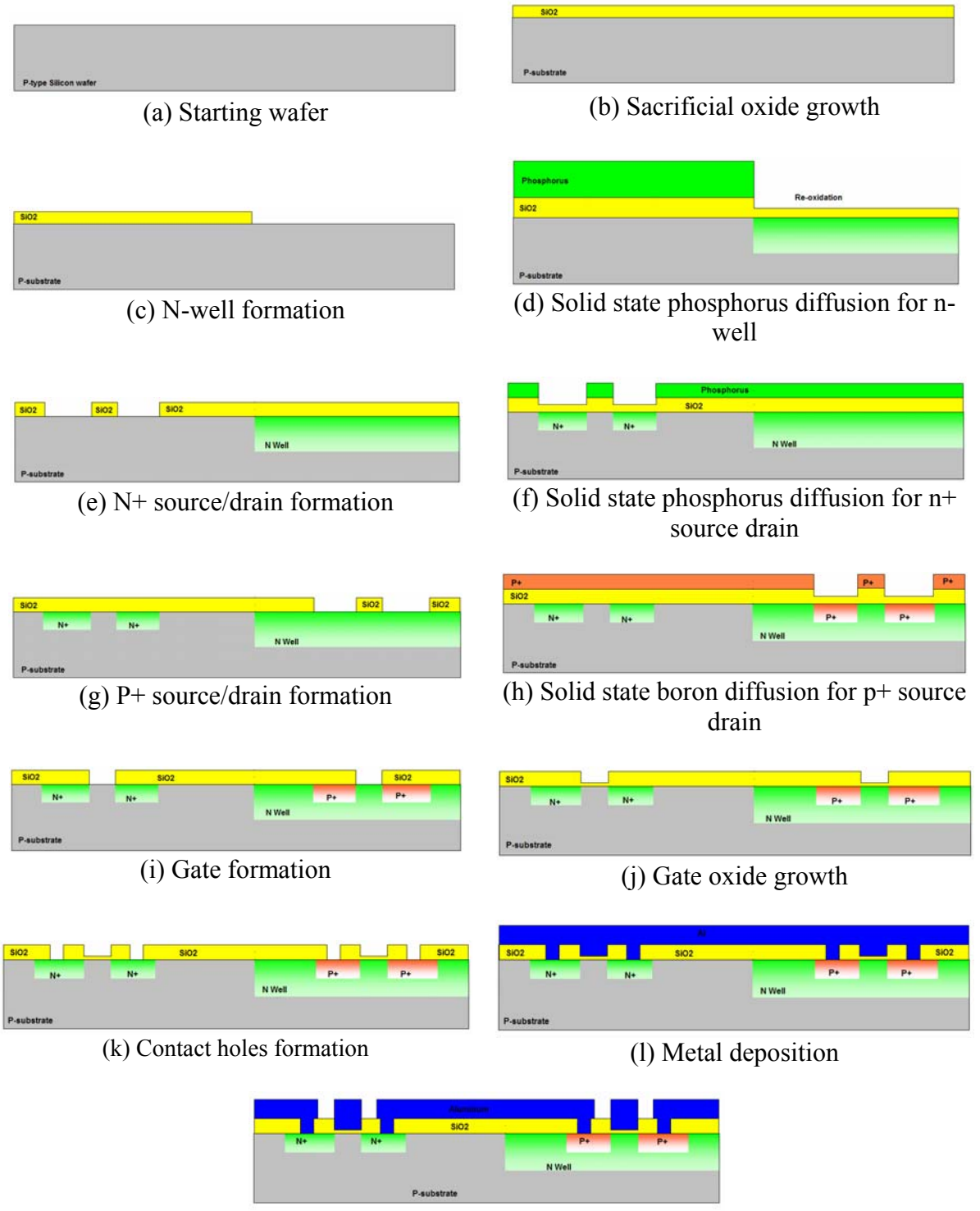


Fig. 4. Cross Section of N-Well CMOS Process.

Fabrication equipments used to process the wafers are dry and wet oxidation furnaces, p-type and n-type diffusion furnaces, wet etching bench, and physical vapour deposition module (PVDM). Oxidation furnaces will be used to grow silicon dioxide layers in wet or dry conditions. A diffusion furnace can be used to grow oxide layer when oxygen is inserted into the process. A diffusion furnace drives the deposited dopants deep into the silicon wafer. Wet etching bench is used to perform chemical etching on the wafers. The PVDM is used to deposit thin films such as aluminium using evaporation technique. Others equipments include spinner coater, hot plate, and the mask aligner are used for photolithography purpose. PNT conduction gauge,

spectrophotometer, profilometer and four point probe are used for wafer measurement. High power optical microscope is used to observe and capture images of device.

4. Conclusion

The N-Well CMOS process developed has simpler process flow, shorter processing time, and affordable to perform in a university microfabrication laboratory. With seven major process steps, six photolithography steps, and safe-friendly materials, the process is perfectly suitable for undergraduates of a semiconductor course to learn and master the skills and the knowledge of basic building blocks technology in IC. The result is the very basic structure of CMOS device and serves well for an education purpose.

Acknowledgements

The authors would like to acknowledge staffs from the School of Microelectronic Engineering and the Micro Fabrication Laboratory for their co-operation in preparing this paper.

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USE OF CFD SOFTWARE IN THE EDUCATION OF UNDERGRADUATE MECHANICAL ENGINEERING STUDENTS

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Abstract

Mechanical engineers need to be aware how computer-aided design can assist them in their work. The software ANSYS Flotran is used extensively in UTP to train students in the basics of computational fluid dynamics. Third year Mechanical Engineering students are given some basic training on the use of the software. They are then given a basic theme and are asked to work in teams in coming up with a practical-based problem, such as flow around a vehicle or in a duct. The theme is varied every semester. A survey of the students in the final year is conducted to gauge their feedback on the usefulness of the instruction they received from the course and is presented here. The general response is that most found the course very useful in formulating their final year projects, either as a main research tool or to provide support data. They also have indicated that they have a much better respect for the capabilities of CFD software in engineering.

Keywords: CFD, undergraduate education, fluid mechanics

1. Introduction

In many engineering applications such as heat sink design and flow assurance of petroleum, knowledge of fluid mechanics is essential to ensure optimum performance of the systems in place. All mechanical engineers are thus expected to have a good grasp of fluid mechanics and it is a common course taught in all engineering programmes in institutes of higher learning. To engage the students in a more interactive learning environment, lecturers have slowly gone away from the traditional lecture and textbook approach and rely more on advanced teaching tools especially those that take advantage of the computer. Availability of simulation software makes it possible to introduce to students a greater level of independent study whereby students are guided towards carrying out analysis of projects of their interest on the computer. This will allow students to use a relatively sophisticated tool on ideas that will be of interest to them instead of being slaved to a specific topic determined by the academic staff. It will also allow a high level of self-sufficiency in learning and contribute to a more satisfying learning environment.

2. Course Structure

Universiti Teknologi PETRONAS (UTP) was established in 1996 with the vision to be a leader in technology education and a center for creativity and innovation. It also aims to produce graduates who are well-rounded and technically competent, with a wealth of practical experience. As part of achieving this vision, the courses are arranged such that practical knowledge, up to 40% is incorporated into the course delivery methods. A way of achieving this is via the multi-mode approach, and in UTP's Fluid Mechanics 2 course, 20 hours of computer laboratory sessions are included into the syllabus. Prior to this the practical portion of the course had been 28 hours[1], but the new approach allows us to achieve better confidence of the users in less time on the software. The lectures cover topics such as the Navier-Stokes equations, laminar-to-turbulent flow transition, turbulent flow, compressible flow. Table 1 shows the course content of the course. All these topics are acknowledged to be important to industry and research. The computer laboratories instruct the students on the usage of typical computational fluid dynamics software. This is in line with the greater importance placed on computer simulations as an analytical tool in industry in order to improve competitiveness, reduce cost and achieve cost savings.

.3. Computing Facilities

As part of the learning experience, students are required to attend two hour lab sessions every week in which a CFD package is used. The instructional classes are arranged such that at most only two students will share a PC. It has been possible most of the time to allow each student to have a PC by themselves. The software utilized is Flotran, which is the ANSYS Multiphysics version 9.0's fluid dynamics solver. The advantage of ANSYS is that it offers a built-in pre- and post-processing capability within the same package. This eliminates the need for new users to move back and forth between different pre- and post-processing software instead of having to move the input files between different pre- and post-processing software. The commands are also relatively straightforward, and the software makes extensive use of the GUI as well as intuitive inputs. The basic concept of modeling, starting from pre-processing, solving and post-processing is illustrated using tutorials for each module, with increasing level of complexity. All these make the software user-friendly for students new to the concept of computer modeling.

The University opted for the University option with allowable finite element nodes of about 15000. These are deemed adequate for 2D and fairly simple 3D geometries. The software runs on workstations equipped with Pentium IV processors, and 2GB installed RAM. The computers are equipped with Windows XP Service Pack 2 OS and 40GB SCSI hard disks. They are hooked up to Proliant DL580 G2 servers each running two Intel Xeon 1.50GHz processors with 1GB installed RAM and 20GB SCSI hard disks. They run with Windows 2000 Server OS. Novell Networks connects the systems and the LAN transfers data at 100 Mbit per second.

Table 1. Course Structure for Fluid Mechanics 2 [2]

Subject Name	Fluid Mechanics 2	
Code	EMB 3052	
Subject Status	Core	
Level	Bachelor	
Credit Value	2	
Prerequisite	Fluid Mechanics 1, Numerical Methods	
Assessment	Coursework - 50 %	
	Final Exam - 50 %	
Lecturer	Rahmat Iskandar Shazi, Sharul Sham Dol	
Semester Taught	Semester 5	
Subject Synopsis	The Navier-Stokes Equations, Boundary Layer Flow, Laminar/Turbulent flow, Introduction to compressible fluids. Philosophy of computational fluid dynamics (CFD). CFD techniques: pre- and post-processing.	
Subject Planning	**The dynamics of viscous fluids**	L – 4 hr
	Presentations of governing equations particularly suitable to CFD	L – 2 hr
	Simple CFD techniques	P – 8 hr
	Introduction to compressible fluids.	L – 4 hr
	Boundary Layer Flow and Characteristics	L – 2 hr
	Flow instabilities and transition from laminar to turbulent	L – 2 hr
	Turbulent flow	L – 2 hr
	Introduction to CFD software	P – 4 hr
	Laminar and Turbulent Flow analysis	P – 4 hr
Reference	**1. Shames, I.H., Mechanics of Fluids, McGraw-Hill , 4th Ed, 2003 (Main Text)** 2. White, F.M., Viscous Fluid Flow, McGraw-Hill, Int'l Ed., 1991 3. D.F Young, B.R Munson, T.H. Okiishi, Fluid Mechanics, John Wiley & Sons, Inc. 2001	

Table 2. Software and Hardware Facilities

SOFTWARE	ANSYS Multiphysics Release 9.0 University Option	30 licenses
COMPUTING HARDWARE	Engineering Workstations Pentium IV 1.4 GHz CPU 2GB RAM 40GB SCSI Hard disk 64MB 3D Built-in Graphics Accelerator 19" Monitor	30 units
	Windows XP Service Pack 2	3 units
	Engineering Servers Proliant DL580 G2	

	Dual Processor Pentium IV 1.5 GHz CPU 1GB RAM 20GB SCSI Hard disk Windows 2000 Server OS	
LOCAL AREA NETWORK	Novell Networks 100Mbps client-server connections	All

4. Learning Approaches

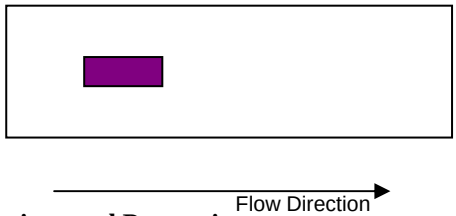
A step-by-step laboratory manual is provided to the students as this is the first time they come across a CFD software. The first few manuals[3] take the students through some of the software's basic capabilities. This is to acclimatize the students to the general outline of the software and its capabilities and limitations. The laboratory modules covers basic geometry creation, fundamentals of modeling, laminar flow, turbulent flow, mesh size affects and compressible flow. These modules are selected and developed based on the general cases of fluid flow problems and typical concepts in fluid modeling when dealing with CFD. Engineers need to appreciate why heat sinks need to be designed in such a way in order to dissipate heat, or how front airdams help keep cars glued to the road. While this is difficult to visualize, it can be achieved using software which can display temperature and pressure gradients on the screen. Based on these manuals, more advanced manuals were created specifically for the course in order to beef up the students' understanding. Figure 1 shows an example of the developed laboratory manuals made available to the students.

Figure 1. Excerpt from laboratory manual [2]

Part SIX: Variation in Mesh Size Example

Problem statement

This example models fluid flow in a 2-D duct with a rectangular object right in the center, which is flow in a closed channel.



Dimensions and Properties :

Total length of duct	10 m
Inlet height of duct	2 m
Length of rectangular object	1 m
Height of rectangular object	0.4 m
Distance of object from inlet	2 m
Height of object from bottom of duct	0.8 m
Air density	1.205 kg/m3
Air viscosity	1.8135 x 10E-5 kg/m-s
Outlet pressure	0 Pa gage
Inlet velocity	3 m/s

Preprocessing (Laminar Analysis)

Step 1 : Set Preferences

1. **Main Menu > Preferences**. Turn on FLOTRAN CFD filtering.
2. OK.

Step 2 : Define Element Type

1. **Main Menu > Preprocessor > Element Type > Add/Edit/Delete**.
2. In the *Element Types* box, choose Add…
3. In the *Library of Element Types* box, choose FLOTRAN CFD, and element 2D FLOTRAN 141.
4. OK.
5. Close.

Step 3 : Create Rectangle for 2-D Duct

1. **Main Menu > Preprocessor > -Modeling-Create > -Areas- Rectangle > By Dimensions**

Step 4: Create Rectangular Object
Step 5: Create Area as Flow Domain

Based on the previous lab exercises, create the flow domain as required.
On the ANSYS Toolbar click SAVE_DB.

Step 6 : Establish mesh patterns.

1. **Utility Menu > Plot > Lines**.
2. **Main Menu > Preprocessor > Mesh Tool**.
3. Choose Lines Set under Size Controls, in the Mesh Tool box.

Now complete the line meshing for the whole flow domain. As a guideline, define two elements for every meter of length.
In the ANSYS Toolbar click SAVE_DB.

Step 7 : Create the finite element mesh.

1. Choose Mapped mesher in the Mesh Tool box.
2. Choose Mesh.
3. Pick All.
4. You might get an error message. That indicates the mesh cannot form a mapped mesh. This means your mesh cannot follow the specified line division you entered earlier without creating some very obtuse quadrilateral elements. Badly

formed elements will lead to errors. **Instead you need to select a Free mesher option**. Select size 8 on the Smart Size option to begin with.
5. Close the Mesh Tool.
6. In the ANSYS Toolbar click SAVE_DB.

As the students are going through the modules, they are asked to work in groups of 3 or 4 on a project assignment within a specific theme, such as Compressible Flow or Flow in Ducts. The students prepare a project proposal along the lines of the theme, the exact topic being of their choice, with the approval of the lecturer. This ensures that the students have a certain degree of leeway to decide on their project, with guidance from the lecturer to ensure the projects are within the scope and not too taxing for the students to carry out. Table 3 lists examples of projects approved to be carried out by the students. The group numbers are controlled such that all of the team members have to be involved in the work. The groups are expected to send in a report on the independent study i.e. approved project by a certain deadline, with a properly written discussion. Should the discussion be deemed to be unsatisfactory or if the students were not able to finish the simulation work the group will be asked to give an oral presentation on the work. This ensures that the students have a chance to better understand what they tried to model.

Although about 20% of the projects could not be carried out successfully i.e. results obtained are not correct, all of the students were able to explain the patterns they were expecting to see and the physics behind those expected observations.

Table 3. Project Titles for Fluid Mechanics 2

	Project Title	**Description of Project**
1.	Slipstream Effect on Proton Gen2	2-D simulation of effect of slipstream on a tailing Gen2
2.	Analyze Flow behavior around a Northrop B-2 Bomber	2-D simulation of flow around a large flying wing
3.	Determining the air flow around a Proton Wira with and without spoiler	2-D simulation, analyzing the effect spoilers have on pressure distribution around the a vehicle
4.	Effect of flow reducers on velocity and flow profile in pipes	2-D axisymetric simulation studying how flow reducers work
5.	Flow distribution differences between a Boeing 747-200 and a 747-300	2-D simulation observing how the 747-300 model experiences less drag compared to the preceding model
6.	Study of flow differences between a soft point and a flat nose bullet	2-D simulation studying how geometric shapes affect the airflow around bullets
7.	Wind tunnel simulation on Air foil NACA 23015	2-D simulation on flow around an airfoil at various angle of attack
8.	Aerodynamic Study of Air flow around a SCANIA 360 124C Truck	2-D simulation studying how flow around a truck behaves and how flow deflectors work
9.	Effect of Wing Flaps	Studying the effect flaps have on the pressure and velocity profile around a wing

5. Feedback on Approach

A survey was conducted for the cohorts that took this course in the years 2005 and 2006. The purpose of the survey was to gauge the effectiveness of the new approach with the independent study mode. Students are asked 10 questions, aimed at gauging:

i. Level of exposure to CAE software
ii. Enhanced understanding of subject matter
iii. Facilitate learning of subject matter and independent learning
iv. Greater confidence in the use of CFD software for future work
v. Perception of enhanced graduate marketability to the industry

Students were asked to rate the above items on a scale of 1 to 5, 1 being 'None at all' and 5 being 'very much'. The survey showed that 85% of the students responded favorably i.e. 4 and 5 on the greater level of confidence on the use of the software for research, as well as on their expected marketability to the industry. Prior to this, students were assigned topics selected by the lecturers, but this constrained the type of projects that can carry out. By allowing and guiding the students as they carry out projects defined themselves, the course enables a greater level of flexibility to the students to determine the material they will study. This independent study approach allows the students' to gain and maintain interest in learning.

6. Discussion

The survey conducted indicates that the inclusion of an independent study approach on top of the inclusion of CFD laboratory sessions brought great improvement in the learning of the students. On top of that, their ability to retain what was learnt improves to the point that their confidence of tackling a research with a CFD component to it increases significantly, especially for their Final Year Projects. Table 4 shows a list of Final Year Project titles where the use of CFD is very prominent.

Table 4. FYP Titles with emphasis on CFD

	FYP Title	**Description of Project**
1.	Effects Of Window Design On The Airflow Into A Building	2-D simulation of window design on building ventilation
2.	Influence of the Turbulence Models on the accuracy of the CFD Code for Low Speed Flows	2-D simulation of turbulence models' effect on low-speed simulation results
3.	A Numerical Simulation Of Turbulent Flow Around Buildings	2-D simulation, analyzing the effect of airflow around large buildings
4.	Development Of A Subsonic Wind Tunnel In UTP	2-D axisymetric simulation of wind tunnel design
5.	Side Tubing Design Of Safety Intravenous Catheters	2-D simulation observing how a side-intake design of IVCs affect fluid flow
6.	Study of Internal Flow of CNG in the Vehicle's Onboard Storage System	2-D simulation studying flow of CNG inside onboard tanks of CNG vehicles

Students do admit to that the course loading is heavy, as an advanced fluid mechanics course usually is. The students appreciate that the topics presented in the lectures are supported by laboratory sessions where they are able to carry out numerical simulations to observe what the theories predict. This approach offers the students the ability to observe their results directly on their screens, instead of having it measured on the apparatus which usually uses air. The ability to visualize what happens and in colours help the students retain the knowledge associated with the theory.

The adoption of the independent study assignment module in the form of a project further enhances the students' learning ability. Students have the option to discuss what they are interested in, and propose that as the problem they will try to model in the computer. Via the discussions, they are able to interact and look at various options before deciding on a topic to zoom in. The level of complexity can be adjusted during the proposal stage in a discussion with the students, giving them a better appreciation of what is possible within their scope. Such an approach allows the students to understand the limits of the software as well as themselves, especially with regard to what is expected of undergraduates. Students will not undertake a problem that is beyond their ability, enabling them to gauge for themselves what is a reasonable fluid problem to tackle.

7. Conclusion

Students have appreciated how relevant the laboratory work is to the theory. On top of that, they are able to apply what they know onto a fluid problem that they define themselves, and how to synthesize a solution method using the software. This includes flow around vehicles, compressible flow in ducts and aerodynamics. The students also identify the importance of CFD in their future career and the potential savings and convenience it brings to the industry, especially the ability to test various configurations before actually committing to a manufacturing decision.

Fluid Mechanics is not an easy subject to master for many undergraduates, given that a lot of the flow is not easily visualized. Without proper motivation as well as an opportunity to put what they have learnt to test, they will not be want to take up the challenge that deals with fluid flow. From the feedback that has been received, it is obvious that the inclusion of CFD into the Fluid Mechanics course with an independent study approach brings benefits to the students through reinforcement and self-application of what was delivered during the laboratory sessions.

Acknowledgements

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Mobile Real-time Feedback/Teaching System

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Abstract

We present in this paper the development of a mobile real-time feedback system using Short Messaging System (SMS) as the feedback mechanism; with discussions on its applications to scenarios in education when some real-time feedback from students is necessary to better direct the delivery of specific teaching materials, lesson planning or the use of an appropriate teaching approach which are best suited to the current learning conditions. The requirements to be met by the scheme, along with their implementation and the field data collected from a variety of application scenarios can be found in the attached paper. The ability to gather immediate individual feedback provided by the technology are far more likely to promote a more adaptive classroom teaching than the passive environment of the traditional lecture class.

Keywords: real-time feedback; mobile system; SMS

1. Introduction

Student feedback is an important element of education. When it is implemented well, student feedback is able to provide the essential information for an educator to improve on his teaching materials, the approach to deliver them, as well as other finer details in education which would benefit even the most experienced educator [1]. However, the timeliness of feedback is a crucial factor governing the extent of its success. In many instances, feedback exercise is carried out on a cohort or students batch basis, at the end of the teaching semester. So, the feedback solicited will be used to direct efforts to improve materials or teaching approach for the next cohort of students. Till now, an efficient and systematic way of soliciting real-time field parameters from the class is mainly possible through smart classrooms with heavy infrastructure and equipment investment, and is limited to a small class [2, 3]. Otherwise, the "quick show of hands" has remained basically as the educator's only tool to seek the simplest "yes/no" immediate feedback from a class. There are many common scenarios when a real-time response and presentation of analysis and consolidated results is needed, especially in a large class. As an example, consider the following scenario:

A tutor would like to have a feel of whether the students are grasping the right concepts, by giving a number of multiple choice questions to a large class. He will hand out the questions, and collect the answers from the class after a timed duration. It will be the next tutorial, or even later, before he has processed the scores and will have the statistics to discuss with the students.

This and other scenarios when it is necessary for an educator to be able to sense the response of the class to his teaching/planning and to have an immediate presentation of the analysis results (so as to be able to respond to them in the most timely manner possible) set the motivation for the work. The key objective is to develop a mobile real-time feedback system which can be utilized by essentially the whole class of students without having to impose any noticeable costs on neither the students nor the school during the process of feedback, and without requiring expensive equipment to be installed in the classroom. One of the main advantage of such a mobile real-time system is that inputs/feedback can be obtained during the lecture/tutorial itself. This is an added advantage compared to the current integrated online learning systems [4] which also provides opportunities for conducting surveys, on-line quizzes

In this paper, the feedback mechanism most viable to meet the requirements will be first identified. The overall configuration of the proposed systems and the off-the-shelves components to realize it will be duly presented. Implementation details and results will be furnished to highlight the usefulness of such a system in enhancing education through timely feedback from students, never before done in a more systematic manner.

Our objective/motivation is to develop a mobile real-time feedback/assessment system that addresses

the issues highlighted in section b. The mobile real-time feedback system must be utilized by essentially the whole class of students without having to impose any noticeable costs on neither the students nor the school during the process of assessment and feedback, and without requiring expensive equipment to be installed in the classroom. One of the main advantage of such a mobile real-time system is that inputs/feedback can be obtained during the lecture/tutorial itself. This is an added advantage compared to the current IVLE [4] system which also provides opportunities for conducting surveys, on-line quizzes.

2. The Technology: Short Messaging System (SMS) as Feedback Mechanism

Mobile subscriber penetration rate amongst tertiary students has been increasing and is expected to continue growing. It is now uncommon to come across a tertiary student who does not own a mobile phone with a basic function like SMS. In addition, with mobile messaging fast becoming a communication tool by choice amongst the students and the general public, the use of mobile messaging as the base mechanism for feedback of information has the highest potential at this point in time as the mechanism which will attract ready participation from the largest pool of students. In Singapore, SMS is now a standard part of any mobile service subscription and there is no additional subscription fee necessary, unlike other services such as WAP/GPRS. In addition, no training is necessary on SMS to students at this level when many junior schools students are already highly proficient at messaging via their mobiles.

The utilization of mobile messaging for surveys, call for donations during charity shows, or request for latest soccer results etc., is already rampantly available in countries with high mobile service penetration rates [5]. While such uses have been rapidly evolving, the systems design and architecture generally utilize SMS on either a GSM modem or an SMS Gateway, as shown in Fig. 1. For approaches based on the GSM Modem, the software is normally a desktop application running on a stand-alone computer system running Windows or Linux [6]. The desktop application provides the user with ownership over the mobile number, but it only supports a single user usage. The setup requires a computer installed with both the GSM modem and the messaging program. As such, this system has a low accessibility factor as the user needs to be physically present at the computer to access the system. For approaches based on the SMS Gateway, the Mobile Service Providers run a web application on which clients can access through a web browser [6]. While this approach may offer higher mobility, it clearly also require the explicit service and support of the service providers, with no owner direct ownership of the system.

Thus, these approaches either require the support of a service provider or they are not amenable to support mass users and yet efficiently reconfigurable (time and cost wise) to seek a variety of feedback at the same time. In this paper, a variant of these architectures which can satisfy the low cost, wide participation base, and absolute controllability aspects of the application will be designed and implemented.

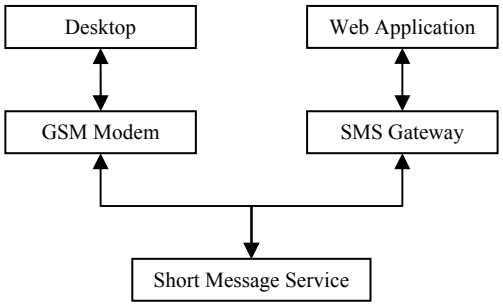

Fig. 1. Current SMS systems.

3. Proposed Solution

In this section, the main components/processes necessary to fulfill the feedback system will be first highlighted. A system configuration to realize these processes will then be proposed, with details of its functionalities and system administration.

3.1. Constituent processes in the feedback system

There are generally five main processes to be present in the mobile messaging feedback system. The question(s) must first be conveyed to the targeted students. The feedback in the form of incoming messages must be consolidated for subsequent analysis. A categorization process will categorize the incoming messages corresponding to the survey/question(s) they are intended for. The user/responder information should be identified and correlated to the response received. Finally, data processing will be necessary to yield the statistics which is needed by the initiator of the feedback session. The five processes are listed in Table 1. A simple example is given below to illustrate the processes and how they will work together to fulfill the functions of the feedback system.

A lecturer is in his office when he wishes to post his class a question on whether they have the basic knowledge on System Control, so as to decide if he needs to go through the basic concepts in his Advanced Control class. He logs on to the SMS Feedback System web portal to create a survey with two options (yes and no) and a unique identifier (control). The question can then be posted onto the whiteboard during class. The students participate in the survey via SMS with either "control yes" or "control no". Once the SMS reaches the server, the

survey is identified by the first word "control" and the student is identified by the mobile number. The answers will then be processed according to the two options available. The processed outcome in terms of the percentage of students with and without prior control knowledge will be made available to him.

Table 1. Processes in the mobile messaging feedback system

Steps	Process
1	Question Dissemination
2	Message Collection
3	Survey Identification
4	User Identification
5	Data Processing

3.2. System Configuration

The proposed system should be able to support multiple users and multiple ongoing surveys. To facilitate operational independence, reconfigurability and future expansion, it is also desirable for the surveyors to have direct physical ownership over the mobile number in the form of the Subscriber Identity Module (SIM) Card. However, the current systems depicted in Figure 1 are not able to fulfill both attributes. A web application based on a GSM modem is potentially able to offer direct ownership, as well as support multiple users and multiple ongoing surveys.

A proposed architecture is given in Fig. 2, and the physical configuration of this system is shown in the block diagram of Fig. 3.

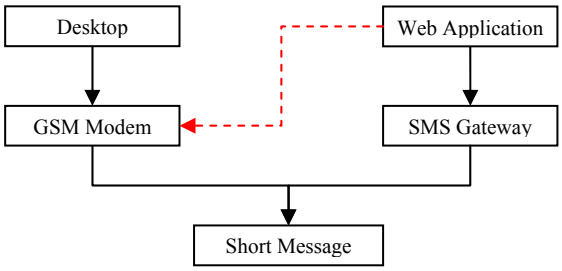

Fig. 2. Proposed web application using GSM modems.

In this proposed configuration, a SMS feedback web application is developed based on a GSM modem. The web application is built totally on Java Technologies using Java Servlet API, Java Communication API, and Java Activation Framework. The application is deployed on Apache Tomcat 5.5 and the Windows 2003 Server Operating System. The computer is linked via USB interface to a GSM modem and GSM communication is enabled by a SIM card from a local mobile service provider. Users are able to create, view and administer the SMS feedback using either the internet browser or the SMS administration tools which will be described in the next subsection.

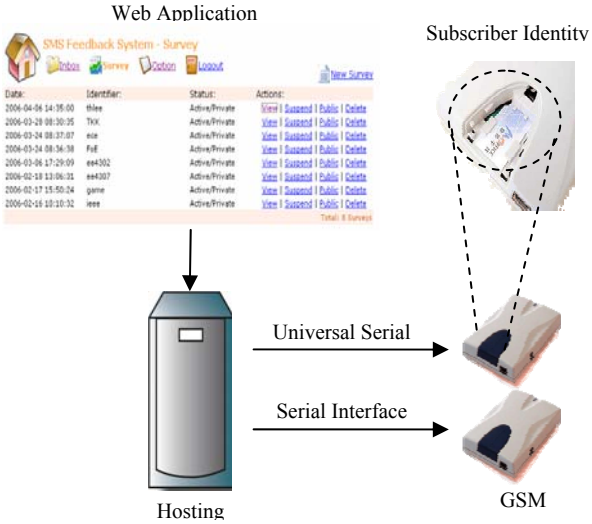

Fig. 3. Physical configuration of web application using GSM modems.

The main challenge in developing the multi-user web application on the GSM modem lies in the synchronization of simultaneous access to the GSM modem. While web applications are built for simultaneous access by multiple users, GSM modems are basically serial devices operating on AT commands. When multiple users simultaneously attempt to send and receive messages, there is a primary need to synchronize the read and write operations executed on the GSM modem.

Table 2: Sending a SMS text message

Steps	Actions
1	Enters Messaging Monitor
2	Disables Data Available Interrupt
3	Enters Read/Write Monitor
4	Transmits "AT+CMGS=+123456789"
5	Leaves Read/Write Monitor
6	Enters Read/Write Monitor
7	Receives ">"
8	Leaves Read/Write Monitor
9	Enters Read/Write Monitor
10	Sends "Hi" following by CTR-Z
11	Leaves Read/Write Monitor
12	Enters Read/Write Monitor
13	Receives "OK"
14	Leaves Read/Write Monitor
15	Enables Data Available Interrupt
16	Leaves Messaging Monitor

Furthermore, each messaging action consists of multiple AT commands in sequence with responses from the GSM modems (see Table 2). Therefore, there is a secondary need to synchronize the respective messaging actions which may contain multiple read and write operations. The implementation deployed for evaluation in this paper

uses two Java monitors to synchronize both the basic read and write operations. In addition, each messaging action should also consider the various serial port interrupts that are enabled in the interrupt register. For example, *Data Available Interrupt* may occur to indicate an incoming SMS.

3.3. System Administration

The administration of mobile messaging feedback in web and desktop application has largely been confined to a graphical user interface application. The possible administration through SMS has not been well explored. With administration through SMS, the user will be able to access the final processed data through his mobile device. This will greatly expand the application of the feedback system as there is no need for even a web browser to access the web portal. Feedback can be conducted even during outdoor field educational trips where there is no computer available. Administrative functions, suitable for SMS administration, include the listing, viewing, posting, editing and deleting of surveys.

Each administrative action must be identified with a unique keyword. The main consideration is that the SMS text messages must be confined to supported character sets and message length. All English characters based SMS text messages must be confined to 160 characters while Unicode characters based SMS text messages must be confined to 70 characters. The identity of the administrator can be further established through the mobile number of the sender of the message.

This constraint can be overcome by concatenated or multiple SMS messages. In such cases, a mechanism should be designed to identify and arrange SMS messages that may arrive out of sequence. This mechanism will be similar to the commonly known methodology used in TCP/IP. However, unless the automation of the SMS indexing and rearrangement can be automated at the sender end, its usage can be complex and tedious.

With this system, any message received from the predetermined administrator mobile number will be checked for administrative action keywords (LIST, VIEW, POST, EDIT and DELETE) associated with the respective administration actions.

To avoid problems on character case error, keywords identification will be case insensitive. Upon detection of the administrative action keywords, the message will be further examined for the specific administrative action commands. If the command is correctly resolved, a SMS text message containing the results will be sent back to the administrator. If there are formatting or system errors, it will alert the administrator with a SMS text message containing the error code and corrective action advices.

4. Implementation and Evaluation

In this section, the implementation details of the mobile feedback system will be furnished for the GSM modem with web application solution, including its costs, systematic run through of the constituent processes and presentation of the application scenarios and results.

4.1. Costs

The total cost for developing the system consists of the deployment and operational costs. The deployment cost for the equipments and software used for the setup as depicted in Figure 3 is shown in Table 3.

Table 3: Deployment Costs

Item	**Costs**
Integno GSM modem (series 3000)	SGD$250
Intel Pentium 4 2.8 GHz, 512 KB Ram, 40 GB Hard disk Computer	SGD$700
Server 2003 Operating System (Academic Edition)	SGD$200
Prepaid Subscriber Identification Module	SGD$18
Total:	**SGD$1168**

With the use of the GSM modem and prepaid card, there is no direct operation cost involved to receive the SMS feedback. For the purpose of SMS administration, the server will need to respond to SMS admin commands with a SMS response. The sending of SMS responses generally comes with a fixed unit cost. The current operational cost structure is given in Table 4.

Table 4: Operational Costs

Item	**Costs**
Sending SMS	SGD$0.05 / SMS
Receiving SMS	Not Applicable

4.2. Illustration of the Processes

To use the web version of the SMS Feedback System, a user would log in to the web site. Upon logging in, he would see the SMS Feedback System Inbox as shown in Fig. 4. On the navigation bar in the order from left to right, the inbox contains a list of incoming SMS replies, the survey link leads to survey management and the listing of existing surveys, the saved message link enable users to compose and send SMS to individuals and groups, mobile contacts can be stored and retrieved through the contacts link, the delivery report link allows users to check on the SMS delivery status, the admin option link allows the user to change his settings, and

the logout link will exit the user from the web application.

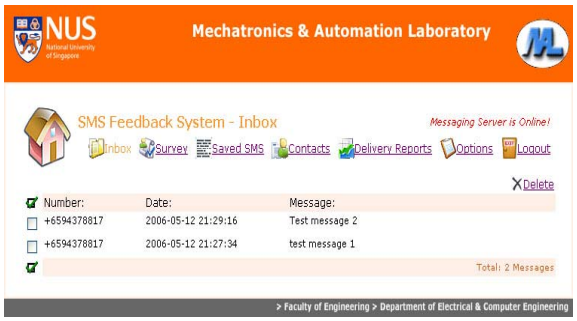

Fig. 4. SMS feedback system – Inbox.

The user of the SMS Feedback System for the first time should click on the *Admin Option* to specify the administrator's settings as shown in Fig. 5 below. The settings include his name which would be appended to the survey for identification by the people who receive the survey questions, his mobile phone number for administrator verification and his preferred administrative keywords which have been discussed in Section 3.3 of this paper.

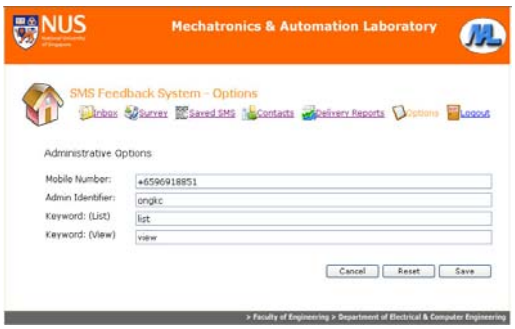

Fig. 5. SMS feedback system - the administrative options.

To create a survey or view a list of current surveys, the user clicks on *Survey* from the main menu. On the survey section of the web service as shown in Fig. 6 below, there is a list of existing surveys that have been created by the user, each with a list of actions which the user can perform on the surveys. The user can also create a survey by clicking on the new survey link located at the top right. From there, he would create the survey question and the survey options as shown in Fig. 7.

Following the creation of the survey, the system is ready to receive feedback. The system contains further capabilities to compose and disseminate the survey question via SMS as shown in Fig. 8 and Fig. 9. In Fig. 8, the user can compose the SMS with the survey question together with the method for taking part in the survey.

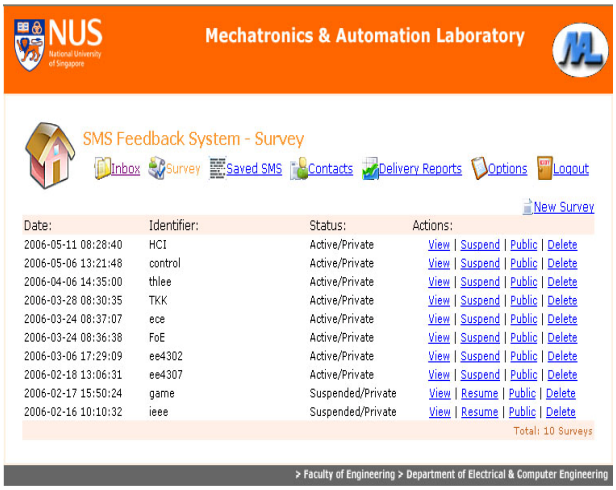

Fig. 6. SMS feedback system - survey section.

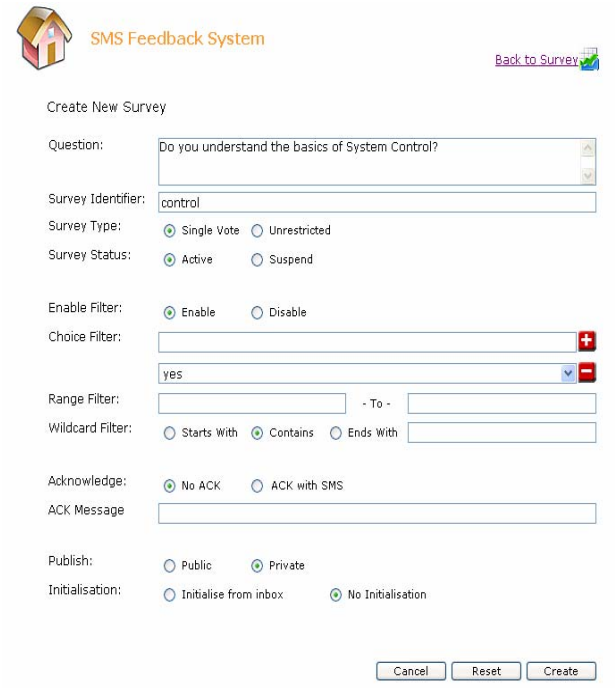

Fig. 7. SMS feedback system – creating a new survey.

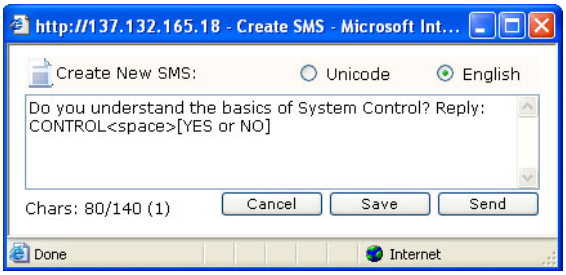

Fig. 8. SMS feedback system – Compose SMS.

In Fig. 9, the user can send the SMS to selected individuals and groups from the contacts lists. When the user wishes to look at the response of a survey, he would click on the *View* action corresponding to the

survey. An example of the view result is shown as Figure.

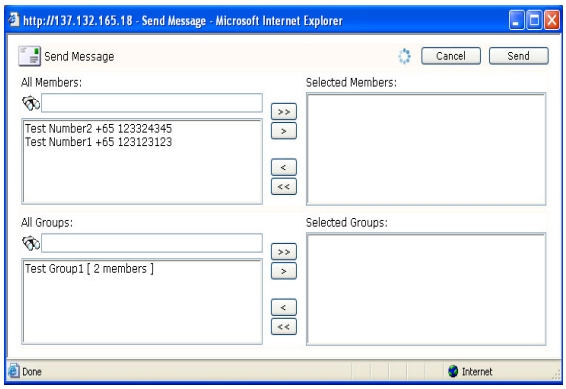

Fig. 9. SMS feedback system – Send SMS.

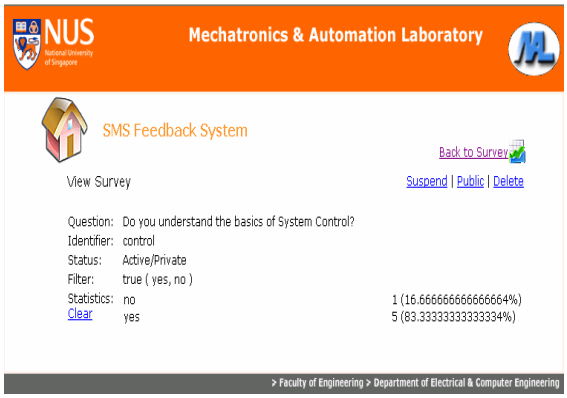

Fig. 10. SMS feedback system – viewing survey results.

He will also be able to see all the responses for all the surveys in the *Inbox* option found on the main menu. It is not necessary for him to have access to a web browser in order to view the results. He may require the results to be sent to his mobile in the form of an SMS through an administrator view SMS command to the server, i.e., *admin view control*. An example of the SMS response from the survey view request is shown in Fig. 11.

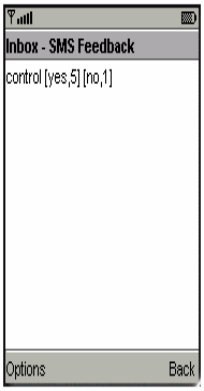

Fig. 11. SMS feedback system – viewing survey results

4.3. Application Scenarios

The mobile feedback system has been used in the following applications which were first raised in Section 1.

- Adaptive Teaching

The system has been used in a class of 50 students over a semester to serve as a fatigue level check for the lecturer to decide, in real-time, the approach to adopt for the latter part of the lecture, depending on the students' fatigue and concentration level. The lecturer has found the feedback very conducive to decide on his next course of activities for his lecture, which can be giving a break, doing a quiz or continuing with his original plans.

- Real-time Quiz

Consider the scenario where instant assessment of quiz is required during lecture/tutorial to assess the ability and understanding of the students before proceeding to the next section/part of the course. Multiple choice quizzes have been conducted in a number of modules, with very encouraging results, not only can the teacher access the performance of the students, the students can also used their mobile devices to check on their performance.

- Immediate Teaching Feedback

The system has been used in three classes, comprising of 50, 80 and 120 students respectively, to collect immediate feedback on the teaching of a guest lecturer as well as the students' perception of the difficulty of quizzes conducted in class. With the system, feedback is available minutes after the request is transmitted to the students. Such a scenario has not been possible in a normal modest classroom, prior to the implementation of the system.

- Class Planning

The system has been applied to a class of 120 to allow the immediate scheduling of a make-up class based on the date and time (out of a range provided) when a maximum number of students can make it. Such logistics arrangement has used to be quite a tedious chore to carry out in the past.

- Outreach Survey

The system has been applied to students outreach activities by soliciting survey of students' relative interest in a whole range of programs available at the National University of Singapore, as well as for prospective students to message for query and attention during the university open house when a large turnout is expected.

There has been no problem with the infrastructure of the system. Close to 100% of students in the classes where the system is experimented on, own the necessary mobile to facilitate the feedback. Feedbacks from the students themselves also show that the small cost is not a problem to them. The

major problem pointed out is the privacy of the mobile number as the number will appear along with the feedback in the *Inbox*. However, this problem can be solved by providing the student with an option (via a simple identifier in the message) as to where they would mind their numbers been made available to the administrator. If the student would like to keep the number private, the application will blank off the numbers from the survey response.

4. Conclusion

Mobile technologies have continued to enable new innovations and approaches in education. The development of a mobile real-time feedback system has been presented in this paper, with details on its requirements, configuration, functionalities and implementation. An alternate version of the system based on mobile application is also presented, offering an integrated solution which does not require a separate GSM modem. The development details, actual application scenarios and results are duly discussed.

Acknowledgements

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