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Implementation of learning outcome attainment measurement system in aviation engineering higher education

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Abstract. This paper aims to discuss the effectiveness of the Learning Outcome Attainment Measurement System in assisting Outcome Based Education (OBE) for Aviation Engineering Higher Education in Malaysia. Direct assessments are discussed to show the implementation processes that become a key role in the successful outcome measurement system. A case study presented in this paper involves investigation on the implementation of the system in Aircraft Structure course for Bachelor in Aircraft Engineering Technology program in UniKL-MIAT. The data has been collected for five semesters, starting from July 2014 until July 2016. The study instruments used include the report generated in Learning Outcomes Measurements System (LOAMS) that contains information on the course learning outcomes (CLO) individual and course average performance reports. The report derived from LOAMS is analyzed and the data analysis has revealed that there is a positive significant correlation between the individual performance and the average performance reports. The results for analysis of variance has further revealed that there is a significant difference in OBE grade score among the report. Independent samples F-test results, on the other hand, indicate that the variances of the two populations are unequal.

1. Introduction

The University Kuala Lumpur-Malaysian Institute of Aviation Technology (else better known UniKL-MIAT) has been gradually growing to become the leading aviation training institution that specialises in aircraft maintenance technology in Malaysia. This is perfectly in line with the increasing needs of national aviation development programmes as laid down in the Malaysian government blueprint. With world class infrastructures, state-of-art facilities, highly trained and multi-skilled teaching personnel, and comprehensive training that complies with the technical standard and industry requirements, the graduates from UniKL-MIAT are expected to be able to meet the demand of current and future aircraft maintenance technology.

UniKL-MIAT is the pioneer aviation institution in Malaysia and is the first Maintenance Training Organisation (MTO) to be approved by Department of Civil Aviation (DCA) Malaysia to offer aircraft maintenance technology programs, therefore it is an Approved Training Organization (ATO) Part 147 in Malaysia. With all these, UniKL-MIAT is responsible to educate and train students, and to prepare them with enough experience to adapt with the real working environment condition to ensure aircraft airworthiness. Besides that, UniKL-MIAT has to embark on the expansion of its programs in order to be accredited under the Malaysian Qualification Agency (MQA) and ensure that the establishment of its programs is recognized and accredited worldwide. This is important in order for it to produce high

quality and marketability graduates. UniKL-MIAT has to comply and meet the requirements imposed by the Malaysian Qualifications Framework (MQF) to obtain the program qualifications and produces higher quality graduates in relation to its education system. However, to monitor the students' learning assessment, MQA has implemented Outcome Based Education (OBE) system to assess the student's Continuous Quality Improvement (CQI). In short, OBE can be considered as an assessment driven and the assessment is used to determine whether or not a qualification, condition, criterion, skill has been achieved. The OBE approach is practically used to determine whether the learning has been successful (i.e. whether the students know what they have learnt or not) and to achieve this, the learners must be assessed using the assessment criteria of the intended outcome.

2. Outcome Based Education (OBE) Implementation at UniKL-MIAT

Ministry of Higher Education Malaysia (MOHE) has advocated OBE as the basis for higher education in Malaysia. Numerous researches have been done to study the needs of emerging and movement from instructional objectives to learning outcomes implementation in higher private institutions in Malaysia. It has been realized that many graduates are jobless as they have nothing outstanding to offer to the job market though they possess degrees and diplomas from recognized institutions. The curriculum review has long recognized the value of analyzing the subject matter to be learned in terms of the intended learning outcomes. In the 1960s, the concept of instructional objectives have attracted attention in the education world [1, 2, 3]. Outcome based does not mean a curriculum-based with outcomes sprinkled on top. It is a transformational way of doing business in education [4]. In brief, OBE is an approach to education in which decisions about the curriculum are driven by the learning outcomes that students should be able to display at the end of the course. These decisions, among others, include curriculum content, educational strategies, student selection and also assessment. In other words, OBE is basically education based on producing particular educational outcomes that focus on what students can actually do after they are taught and expect all learners or students to successfully achieve the certain particular (sometimes minimum) level of knowledge and abilities.

Education that is outcome-based is a learner centred, results oriented system founded on the belief that all individuals can learn. In an effort to create a higher institution provider with the highest quality graduates, the Malaysian government has started to implement MQF at the end of year 2007. With its role as the reference place of higher learning, MQF emphasizes education based on learning outcomes and decides to adopt OBE in higher private institutions with the guaranteed quality control. MQF is an instrument to develop and classify qualifications based on a set of criteria that are approved nationally and benchmarked against international best practices. The criteria clarify the earned academic levels, learning outcomes of study areas and credit system based on the student's academic load as guided in Malaysian Qualification Act (2007). These criteria have been accepted and used for all qualifications awarded by recognized higher education providers in Malaysia. MQF provides educational pathways that systematically link the qualifications, which will enable the individual to progress through credit transfers and accreditation of prior experiential learning in the context of lifelong learning.

UniKL-MIAT has also gone through several changes in the curriculum and syllabus of its programs to obtain recognition either from MQA and DCA Malaysia to ensure its graduates are marketable and capable to perform the job tasks through hands-on training methods. Based on the collected responses from a conducted survey among UniKL-MIAT alumni, it is shown that UniKL-MIAT has successfully produced graduates who are supporting the local and international aviation industry, and only a few of them are filling vacancies in non-aviation sectors. Up until now, the curriculum has been continually evolved to ensure that the graduates are well-equipped with the knowledge and experience to enter the industry [5]. This approach is known as Continuous Quality Improvement (CQI), which can be seen as a real benefit of OBE implementation. Furthermore, the quality of a programme is ultimately assessed by the ability of the learner to carry out their expected roles and responsibilities. This requires the programme to have a clear statement of the learning outcomes to be achieved by the learner as guided by Code of Practice for Programme Accreditation (COPPA) [6]. The learning outcomes cumulatively should reflect on eight (8) domains of learning outcomes that are significant for Malaysia according to

MQF, which are knowledge; practical skills; communication; social skills and responsibilities; values, attitudes and professionalism; information management and lifelong learning skills; leadership and team skills; problem solving and scientific skills; and managerial and entrepreneurial skills. Learning outcome is necessary in any education institution since it is written with specific intention and needs to be addressed by the program. The idea of learning outcome has some common features with the move to instructional objectives that became fashionable in the 1960s. However, five important differences between learning outcomes and instructional objectives can be recognized as follow:

- Learning outcomes, when appropriately set out, are intuitive and user friendly. They can be used easily in curriculum planning, in teaching and learning and in assessment.
- Learning outcomes are broad statements and typically designed around a framework of 8–12 higher order outcomes.
- The outcomes recognize the authentic interaction and also integration in clinical practice of knowledge, skills and attitudes and the artificiality of separating them.
- Learning outcomes represent what is achieved and assessed at the end of a course of study and not only the aspirations or what is intended to be achieved.
- A design-down approach encourages ownership of the outcomes by teachers and students.

In the meantime, the principle of OBE can be defined as follows [7]:

- Clarity of focus about outcomes: Always have the outcomes as the focus and let the students know what they are aiming for.
- Designing backwards: Design curriculum backward by using the major outcomes as the focus and linking all planning, teaching and assessment decisions directly to these outcomes.
- Consistent, high expectations of success: Set the expectation that OBE is for ALL learners and expect students to succeed by providing them encouragement to engage deeply with the issues they are learning and to achieve the high challenging standard set [4].
- Expanded opportunity: Develop curriculum to give scope to every learner to learn in his/her own pace and cater for individual needs and differences, for example, expansion of available time and resources so that all students succeed in reaching the exit outcomes.

Assessment of students is a crucial aspect of the quality assurance since it drives student learning and is one of the measures to show achievement of learning outcomes stipulated for the programme that is the basis in awarding qualifications. Hence, methods of student assessment have to be clear, consistent, effective, reliable, in line with current practices and must clearly support the achievement of the learning outcomes. The methods of assessment will depend on the specific requirements of each module. However, as a general guide, the following must be considered:

- The usage of summative and formative assessments.
- Knowledge and understanding (the cognitive domain) should be accessed through written, oral or other suitable means, but practical skills should be assessed by practical evaluation such as laboratory, workshop, computer-based simulation and project work.
- For modules requiring significant practical skills, a pass in practical evaluation is compulsory. A pass indicates that the examiner, using an appropriate assessment tool, is satisfied that the candidate has met the learning outcomes of the particular module.

Lecturers in UniKL-MIAT have been encouraged to apply a variety of methods and tools that are appropriate for measuring learning outcomes since the method of studies comprises of theoretical and practical parts with more hands-on training provided for the students to prepare them with adequate knowledge and skills in-line with the technology advancement. CQI of the graduates can be accessed through their assessment and also exit survey. A comprehensive overview of the history and evolution of the CQI methodology is provided in Ref. [8], which is generally a process of constantly introducing small incremental changes in order to improve quality and/or efficiency. One of the methods that can

be adapted for this purpose is Plan-Do-Check-Act (PDCA) Cycle, which is a four-phase, fact-based approach. The four phases are defined as follow [9]:

- Plan: define purpose, goals and objectives, and collect data.
- Do: identify needs, propose change, implement.
- Check: monitor, evaluate and analyze change, and compare old and new data.
- Act: adjust strategies for improvement; Refine and reinstitute.

Sometimes called a team involvement tool, the PDCA Cycle requires a commitment and "continuous conversations with as many stakeholders as possible. . . (it) is a constant process" [10]. Stakeholders here include professionals and academics [11, 12, 13]. CQI requires functional teams and utilizes the team approach to critically assess the process and to devise solutions to problems and new products. This PDCA cycle or an alternative methodology is employed in process analysis, problem solving, and implementation of solutions. The ability to trust and completely interact with others (interdependence) is a desirable characteristic to serve as an individual basis for CQI.

UniKL-MIAT teaching and learning process flow is shown in Figure 1. It is an approach to quality management that builds on UniKL-MIAT vision to be the premier entrepreneurial technical university and its mission to produce enterprising global technopreneurs. OBE has already been introduced and implemented since 2011. One of the measures of its effectiveness is to assess the Program Educational Objective (PEO), Program Learning Outcome (PLO) and intended Course Learning Outcomes (CLO) through the systematic direct assessment using the Learning Outcome Attainment System (LOAMS) and indirect assessment using Graduate Exit Survey (GES). This assessment provides proper strategic plan to ensure the best action may be taken by the management team.

Figure 1: UniKL-MIAT teaching and learning process flow

Currently, course developments in UniKL MIAT are done based upon some steps as the following list;

1. Identify the PLOs and PEOs
2. Set the CLOs
3. Rationalize inclusion of course within the programme.
4. Map CLOs to PLOs and PEOs.
5. Identify transferable skills.
6. Identify mode of delivery and its Learning and Teaching Assessment (LTA).
7. Identify types of assessments.
8. Create Student Learning Time (SLT) for content topics and outline for the course.
9. Allocate the appropriate SLT for each topic and calculate the total SLT.
10. Calculate the credit hours for the course.

LOAMS is an automated system to measure attainment of learning outcomes for all undergraduate programmes in UniKL and it is controlled by the Centre for Instructional Technology and Curriculum Development (CITC). This is one of the university's efforts to systematically implement the concept and philosophy of OBE with respect to curriculum continual improvements. In conjunction to this, Curriculum and Delivery Handbook has been developed by the CITC unit to guide all teaching staff in preparing their course syllabus, which is accessible through e-citie system. The CITC has encouraged teaching staffs to update their e-citie system and has also performed mentoring sessions through briefing and regular meeting with teaching staff and management group. Teaching staff should update all the assessment in the e-citie system and this is continuously monitored by CITC. Figure 2 shows the E-Citie Service Setting System whereas Figure 3 shows the setting up of LOAMS in the system. Prior to the utilization of LOAMS, all teaching staff must understand the concept of OBE that includes alignment of assessments principles, methods and practices to the learning outcomes and programme content delivery, and ensure that assessments must be consistent with the levels defined in the 8 MQF learning domains. With LOAMS, the result of each subject may be generated by each lecturer after the submission all assessment marks including quizzes, assignments, practical mark assessments, midterm examination and final exam. In the system, OBR001 is the corresponding CLO result for each type of assessment while OBR002 shows the course analysis for each CLO and its attainment percentage.

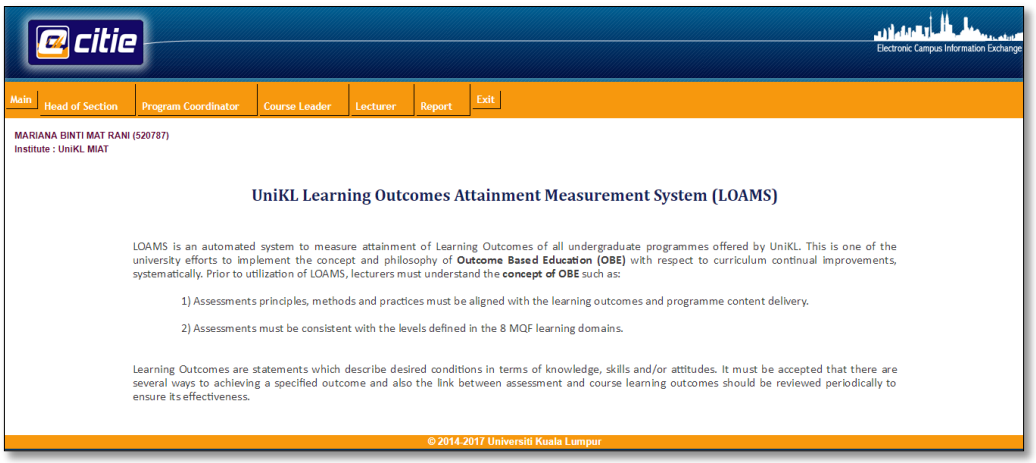

Figure 2: E-Citie service setting system

Figure 3: E-Citie LOAMS set up

3. Implementation Case Study: Course AAB20503

To better highlight the practicality of LOAMS implementation, an example case of Course AAB20503 is presented. This Aircraft Structure course has been conducted for session between January 2015 and January 2016, and its contents include the sub-modules of 7.8, 7.14, 7.15, 7.18, 11.2 and 11.3 as per Department of Civil Aviation Malaysia Airworthiness Notices (AN)1101 Issue 1 dated on 1st January 2011. This Airworthiness Notice is issued in pursuant to Section 24 of the Civil Aviation Act 1969 for DCAM Part 66 Aircraft Maintenance License. This case study involved more than 99 students from the same cohort. The OBE report generated from LOAMS, including information regarding the course learning outcome of individual performance and average gap, has been rated by the lecturer. Reports on each of its course learning outcomes have been analysed and the instrument has been standardized for all OBE implementation in discipline core subjects at UniKL-MIAT.

As a standard practice, each lecturer needs to key in the CLO mapping with current PEO and PLO before the first week of the academic semester. The lecturer should perform the lectures as per course portfolio and the teaching portfolio prepared by the lecturer will be approved by their respective Head of Section. Any change on the subject content should be endorsed by Quality Assurance Unit, with the approval of their expert work group and Head of Section, through the submission of the curriculum amendment form. Students are assessed by some assessment methods including assignment, quizzes, practical worksheet, midterm examination and final examination. Final examination is conducted at the end of each semester and it is controlled by the approved exam unit. All final examination question banks are controlled to ensure the quality of the students' results before they are made eligible to sit for their licensing examination in order for them to become license aircraft engineer. The results from OBE are applied to identify the level of students' knowledge to determine whether they are qualified and competent to sit for the licensing examination. By doing so, the failure rate of students in the exam will be minimized and this provides a good result for the aviation training organization industry. Other than that, UniKL-MIAT has also been practicing blended learning using its e-learning platform, which can be accessed by the students once they are enrolled under the subject. Students may download and retrieve important information necessary for the subject including training notes, students' handout, presentation slides, practical worksheet, assignment, quiz and other supporting materials prepared by their respective lecturer. Some of the assessments may be accessed online and students may use the forum column to discuss some issues related with the subject.

The assessment of the students will be done in the ninth week of the technical academic calendar and the final marks should be submitted a week after the final exam date. The OBE performance is calculated based on individual performance, average rating score and by the headcount to evaluate the course learning outcome and lecturer should ensure that all CLOs are attained. If the result shows that any CLO is not attained, a moderation form should be prepared by the subject matter expert who acts as the subject leader and it needs to be agreed by their respective group before any amendment is done to the subject. The last part to complete the OBE and CQI cycle is the GES that is often filled by the students at the end of the semester.

For the sample course AAB20503, the descriptive analysis including frequency, mean and standard deviation is to indicate and conclude the data collected from LOAMS. Pearson correlation analysis, analysis of variance (ANOVA) and independent samples t-test have been carried out to evaluate the significance of the variables under study. As shown in Table 1, a correlation coefficient of +1 indicates a perfect positive correlation between individual performance and average performance parameters. As individual performance increases, average performance also increases, and vice versa. On the other hand, the results of ANOVA is shown in Table 2 that highlight the significant difference between the individual performance and average performance parameters. Nonetheless, the ANOVA results do not indicate where the difference lies, hence t-test should be conducted to test each pair of means since the outcomes of ANOVA should contribute the expected values of the errors are zero, the variances of all errors are equal to each other, the errors are independent and they are normally distributed. Descriptive statistics of the data is tabulated in Table 3 and they show that the mode, mean and standard deviation of individual performance is greater than average performance.

Table 1: Correlation between individual performance and average performance

	Individual Performance	**Average Performance**
Individual Performance	1	
Average Performance	0.082250554	1

Table 2: ANOVA results

SUMMARY						
Groups		**Count**	**Sum**	**Average**	**Variance**	
Individual Performance		100	8226.9	82.269	183.5582	
Average Performance		100	8348.9	83.489	3.0526	
ANOVA						
Source of Variation	**Sum of Squares**	**df**	**Mean Square**	**F**	***p*-value**	**F_{crit}**
Between Groups	74.395602	1	74.3956	0.797334	0.372976	3.888853
Within Groups	18474.46936	198	93.3054			
Total	18548.86496	199				

Table 3: Descriptive statistics on OBE individual performance and average performance

Individual Performance		**Average Performance**	
Mean	82.269	Mean	83.4888
Standard Error	1.354836406	Standard Error	0.174717855
Median	84.8	Median	83.66
Mode	85.1	Mode	82.62
Standard Deviation	13.54836406	Standard Deviation	1.747178551
Sample Variance	183.5581687	Sample Variance	3.052632889
Kurtosis	27.74619209	Kurtosis	0.946135038
Skewness	-5.255829247	Skewness	0.467918685
Range	90.3	Range	7.1
Minimum	0	Minimum	80.3
Maximum	90.3	Maximum	87.4
Sum	8226.9	Sum	8348.88
Count	100	Count	100
Confidence Level (95%)	2.688289294	Confidence Level (95%)	0.346678121

In addition, Table 4 shows the results of *F*-test two-sample for variances used to compare statistical models that have been fitted to the data set to identify the model that best fits the population from which the data are sampled. After that, the *t*-test is used to test the null hypothesis that the means of two populations are equal. Therefore, in this case, individual performance and average performance of 99 students are equal is known as the null hypothesis. The results of this *t*-test are tabulated in Table 5,

which show that variance of individual performance is higher than that of average performance. In this case, the null hypothesis is rejected implying that variances of the two populations are not equal to each other. Moreover, a two-tail *t*-test (inequality) is then conducted in which the null hypothesis is not rejected, indicating that observed difference between the sample means is not convincing enough to say that the average number of individual performance and average performance are significantly different.

Table 4: Result of *F*-test two-sample for variances

	Individual Performance	**Average Performance**
Mean	82.78245614	83.22666667
Variance	230.2768296	0.412390476
Observations	57	57
df	56	56
F	558.3951203	
P(F<=f) one-tail	4.23E-62	
F Critical one-tail	1.557933377	

Table 5: Result of *t*-test two-sample assuming unequal variances

	Individual Performance	**Average Performance**
Mean	82.78245614	83.22666667
Variance	230.2768296	0.412390476
Observations	57	57
Hypothesized Mean Difference	0	
df	56	
t Stat	-0.220806891	
P(T<=t) one-tail	0.413022945	
t Critical one-tail	1.672522304	
P(T<=t) two-tail	0.82604589	
t Critical two-tail	2.003240704	

4. Conclusion

It can be concluded that there is a perfect positive correlation between the individual performance and average performance of OBE as retrieved in LOAMS data. However, as shown in few other analyses done in this study, it appears that the individual performance is slightly related to average performance of OBE. However, this finding also suggests that some lower grades of individual performance will be hidden once the average performance is taken and the attainment on each CLO statement is not 100%. Independent samples *F*-test have revealed that the variances of the two populations are unequal and *t*-test results show that they are not significantly related. The *t*-test shows that the difference between the sample means is not plausible enough to conclude that the average number of individual performance and average performance is differing significantly. This use of LOAMS has shown a positive feedback from the lecturers and students. This systematic approach is considered as direct measurement method that provides a structured way to analyze the attainment outcomes for each course. Using this system, the lecturer could key in the relevant data and assess the CO attainment for their subject. The analysis

and result will be automatically produced. This system is continuously improved and helpful features are added.

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