Evaluating the Performance of Open Distance Learners in *Introductory Statistics* at the Open University Malaysia

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ABSTRACT :

The study was conducted on degree students embarked on the open distance learning programme at the Open University Malaysia. The objective was to evaluate the performance of the students in the subject, Introduction to Statistics. A cross-sectional, single-stage, stratified random sampling design was employed for the study. A sample of 200 students was selected and complete responses were received for 127(63.5%) of the cases. Findings from the study revealed that the overall mean score for the subject was 54.2 with a standard deviation of 16 and a hypothesis test conducted showed no significant difference in the mean scores among gender. Results from logistic regression analysis revealed that the factors that contributed significantly in the likelihood of a student's performance falling in the '50 and above' score category were, 'able to complete assignment in time', 'time allowed to complete exam' and 'hours of study allocated per week'.

1. INTRODUCTION :

Statistics educators, over the years concur on the fact that basic statistics should be a general education requirement and should be incorporated into the post–secondary curriculum. Hogg (1991) suggested that statistics at the introductory level should be promoted as a tool of research by addressing the formulation of approach questions, effective data collection, interpretation, summarization and presentation of data with attention to the limitations of statistical inference. Hogg (1991) further observed that 'good statistics' is not equated with mathematical rigor or purity but is more closely associated with careful thinking.

Statistics in the modern world plays a key role in developing the ability and competence of professionals, government servants, business community and the ordinary citizens to use and evaluate data effectively. Efforts should be taken by the statistical community in the country to promote statistics as a separate subject in the education curriculum. Statistics education should be implemented right from the primary school level and be made a core module in courses relating to management, business and science at the tertiary level.

If students have been exposed to statistics education from the elementary level, upon reaching the tertiary level they would have acquired some knowledge on the analytical techniques and interpretation of results. With exposure to more advanced areas in statistics at the tertiary level, students would be better equipped with the essential statistical tools which would facilitate them in carrying out analysis of data effectively when conducting a research.

Many degree programs have incorporated

introductory statistics into their curriculum so that students graduating from these programs will acquire some basic skills in analyzing and interpreting data. Introductory elements of statistics are being taught in primary and secondary schools in Malaysia. However, the subject has always been a part of mathematics and has never been taught as an individual module.

Today, many programs which are conducted on a full-time basis are also conducted through a distance education mode. Courses which are theoretical in nature, such as Law or Management courses, are pursued by students without much difficulty, particularly those with a good command of language, through a distance education program. However, those who choose to pursue courses which include some quantitative modules, such as Statistics or Mathematics, may face some challenges due to the technical nature of these subjects and the constraints they experience in embarking on a distance education as compared to their counterparts who are on a full-time program.

There is a general perception that Malaysian students on the whole do not perform well in statistics or statistically related subjects, such as Business Modelling and Decision Making Techniques. It is envisaged that the situation however, could be more serious for those pursuing their degrees through distance education. The reasons being, these students, most of whom are working adults, to a large extent proceed with their studies on a self-study mode and have only a limited number of tutorial sessions per module with their tutors as compared to full-time on campus students who are in frequent contact with their lecturers and tutors.

Many studies have been conducted in the area of distance learning, statistics education and online statistics education and a number of these studies have done comparisons between distance learners and traditional full-time students on specific characteristics.

The role of the online tutor is very crucial in an online learning program. As pointed out by Sloboda (2005), online learning is more student centred with learners taking responsibility for the learning process and therefore facilitators need to be more proactive than in a traditional class setting. A study by O'Malley and Mc Crew (1999), *'Students' Perception of Distance Learning, Online Learning and Traditional Classrooms'*, revealed that students perceived online learning had a significant relative advantage to traditional methodologies. These advantages include, saving their time, fitting in better with their schedules and enabling them to take more courses.

Interaction among peers is vital in an online learning program. Kanyongo (2005) in his paper, *'Teaching an Introductory Graduate Statistics Course to Teachers Preparing to become Principals'*, noted that collaboration is an important part in most of the innovative courses delivered via the Web. Groups of learners interact and develop the attributes of a *'virtual learning community'* even though they may never meet in the same place or same time. Shrage (1991) as cited by Kanyongo, defined collaboration as the process of shared creation of two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own.

Besides having group discussions with their peers, students need to interact with their tutors to seek clarifications on any issues pertaining to their lessons and also to ensure that they are progressing in the 'correct path'. Schmidt and Gallegos (2001) in their research, *'Distance Learning: Issues and Concerns of Distance Learners'*, highlighted the fact that importance should be given to student and instructor interaction which affects how well student learn. The findings from their research showed that 74.3% of the respondents considered student instructor interaction to be important to very important. Tudor (2006) in his paper, *'Teaching Introductory Statistics Online – Satisfying the Student'*, commented that one of the components of a successful online introductory statistics course is student-professor interaction. The author quoted several other researchers,

such as Fulford and Zhang (1993), Kearsley (1995), and Sherry (1996) to confirm that many studies supported the concept that student-to-professor and student-to-student interaction are important elements in the design of an online course.

A well designed, well planned online learning program, supported with the essential online materials and resources can be as effective as a full-time on campus program. However, as mentioned above (Sloboda, 2005), students should take responsibility for their learning process and facilitators need to be more proactive than in a traditional class setting, both of which are necessary for a successful completion of the program by the student. Dutton and Dutton (2005), in their research *'Characteristics and Performance of Students in an Online Section of Business Statistics'*, compared students in online and lecture sections of a business statistics class taught simultaneously by the same instructor using same content, assignments, and exams. The researchers made a comparison of the academic performance and found that the students in the online section had higher academic performance compared to those in the lecture sections, even though controlled for other important variables. Schou (2006) in her paper, *'A Study of Students' Attitudes and Performance in an Online Introductory Business Statistics Class'*, provided evidence that learning outcomes for online students and traditionally taught students are not different for an introductory business statistics course. In addition, students in the online environment showed improvement in their attitudes towards statistics after instructions. A comparison on the mean score on final exam showed no significant difference between the online students and the traditionally taught students.

This research, besides evaluating the overall performance of the students in Introductory Statistics, also examined the factors that contributed significantly in determining the likelihood of a student's performance in the subject falling in the '50 & above' score category.

2. METHODS :

The list of undergraduate students maintained by the examination department, at the Open University Malaysia (OUM), registered for the subject, Introduction to Statistics, for the September 2009 and January 2010 semesters served as the sampling frame for the study. This was the most up-to-date list available prior to the selection process. The list contained information on the name of the student, subject, status (active/non-active), mailing address, phone number, and email address.

A cross-sectional, single-stage stratified random sampling design was employed for the study. The sampling unit was the 'degree student' enrolled for the subject, for the semesters mentioned above.

A sample of 200 students was selected from the 'frame' of which 127(63.5%) complete responses were received. Linear systematic selection technique was used for the selection of the sample. Geographically, the sample selected for the study comprised of students from all the states in Malaysia.

Data were collected through self-administered questionnaires, which were mailed to the students who had been selected for the study. An introduction letter and a self-addressed envelope were sent together with the questionnaire. The contents of the introduction letter included the objectives of the study, statements requesting for cooperation to fill in the questionnaire and assurance on the confidentiality of information obtained from the students. The students were requested to return the completed questionnaire in the self-addressed envelope sent to them.

Duration of two weeks was given to the students to return the completed questionnaires. For those who did not respond within the stipulated two week period, reminders were sent through the e-mail and for those without e-mail addresses telephone calls were made requesting them to return the completed questionnaires. The follow-up on the non-responses covered a period of about a month after which the data collection process was stopped.

3. DATA ANALYSIS AND DISCUSSION

The overall examination score of a student in the subject, Introduction to Statistics was based on an aggregate score obtained by the student in the assignment, mid-term examination and final examination. Summary statistics on the exam score by gender were generated and the independent sample t-test was conducted to determine whether there was a significant difference in the exam score among the gender. An investigation was also carried out using logistic regression to determine the factors that contributed significantly in predicting the performance level of a student falling in the '50 & above' score category, wherein the diagnostic features of the model are also presented to provide an indication on the validity of the model. The findings on the items mentioned above are discussed in the following sections.

3.1 Descriptive Measures and Normality Test :

As noted in Table 1, the exam scores for the 59 male students ranged from a minimum of 21 to a maximum of 96.5. The mean score was 54.50 with a standard deviation of 15.62. In the case of the 68 female students, the exam scores ranged from a minimum of 4 to a maximum of 90. The mean score was 54.02 with a standard deviation of 16.53. At the overall level, the mean was 54.24 with a standard deviation of 16.05. The CVs indicated that the extent of variability of the scores about the mean were slightly higher for the female students as compared to the male students.

The Shapiro-Wilk test showed p-values of 0.498 and 0.057 for the normality test on the distribution of exam scores for male and female students respectively, both of which are above the chosen 0.05 level of significance. From these results it was concluded that the distribution of exam scores within each gender was *not* significantly different from the normal distribution.

3.2 Test of Significance of Mean

Difference in Exam Score Among Gender :

With the normality assumption of the distribution of exam scores for male and female students satisfied, the independent sample t-test was conducted to determine whether the mean exam scores among the gender were significantly different. The SPSS output of the test results are shown in Table 2.

It is noted that the results for Levene's test, shown in Table 2, did not indicate significant difference in the variability of exam scores among the gender – (F = 0.015, p value = 0.902 > 0.05). The homogeneity of variance assumption for exam score among gender required for the test was satisfied.

Referring to the first row (*Equal Variance Assumed*) in the table above, it can be concluded that the mean score among the gender was not significant – (t = 0.167, p = 0.868 > 0.05). The sample did not provide sufficient evidences to indicate that there was significant difference in the mean exam scores among the gender.

The following results also provide support for the above conclusions.

(i) The 95% confidence interval for the mean difference is (-5.1951, 6.151), which includes a zero.

(ii) The effect size, measured by eta-squared is given by,

$$\eta^2 = \frac{t^2}{t^2 + df} = \frac{0.167^2}{0.167^2 + 125} = 0.000223$$

The effect size of 0.000223 is very small, based on the guidelines by Cohen (1998), cited by Pallant (2007), where, 0.01 = small effect, 0.06 = moderate effect and 0.14 = large effect. Expressed as a percentage, only 0.0223% of the variance in the performance of the student in the subject is explained by sex.

3.3 Predictive Factors of Performance in Introductory Statistics – Logistic Regression Analysis :

Table 1 : Summary Statistics and p-values for Shapiro-Wilk Test for Exam Score by Gender

Gender	Statistics						
	N	Minimum	Maximum	Mean	SD	CV%	p value
Male	59	21.0	96.5	54.50	15.62	28.66	0.498
Female	68	4.0	90.0	54.02	16.53	30.50	0.057
Overall sample	127	4.0	96.5	54.24	16.05	29.59	

Note. N, number of subjects; *SD*, standard deviation; CV, coefficient of variation.

According to Pallant (2007), "Logistic regression allows us to assess how well a set of predictor variables predicts or explains the categorical dependent variable. It gives an indication of the adequacy of the model (set of predictor variables) by assessing 'goodness of fit'. It provides an indication of the relative importance of each predictor variable or the interaction among the predictor variables. It provides a summary of the accuracy of the classification of cases based on the mode, allowing the calculation of the sensitivity and specificity of the model and the positive and negative predictive values. Logistic regression does not make assumptions concerning the distribution of scores for the predictor variables; however, it is sensitive to high correlations among the predictor variables (multicollinearity). Outliers can also influence the results of logistic regression."

3.4 The Logistic Regression Model :

The estimated coefficients for the independent variables (Hair et al., 2006) are obtained using the logit value or the odds value as the dependent measure as follows:

$$Logit_i = \ln\left[\frac{\text{Pr}ob_{event}}{1-\text{Pr}ob_{event}}\right] = b_o + b_1 X_1 + ... + b_n X_n$$

$$Odds_i = \left[\frac{\text{Pr }ob_{event}}{1-\text{Pr }ob_{event}}\right] = e^{\,b_o + b_1 X_1 + ... + b_n X_n}$$

The maximum likelihood procedure is used in an interactive manner to find the most likely estimates for the coefficients.

3.5 Variables Used in the Model :

Students by and large did not have prior statistical knowledge or e-learning experiences. It was also noted that age did not show any form of association with performance level.

Independent variables which exhibited relationship with the level of performance were used as predictors. The variables were, *'number of hours of study allocated per week'*, *'enough time given to complete exam'*, *'tutorial sessions sufficient or not'*, *'able to complete assignment in time'*, *'participation in group discussions'*, and *'frequency of participation in myLMS'*.
(N.B:myLMS is an electronic communication tool provided to facilitate interaction among learners, tutors and facilitators)

There were no strong correlations among the predictor variables which ruled out the problem of multicollinearity, a condition which need to be satisfied in logistic regression analysis. The main SPSS logistic regression outputs are shown in Tables 3 and 4.

Direct logistic regression was conducted to assess the impact of a number of factors on the likelihood of a student performance falling in the score category -'50 and above' in the subject, Introduction to Statistics. The model contained the six independent variables mentioned above.

The full model containing all predictors was statistically significant; $\chi^2(5, N=127) = 79.192$, p < 0.0005, indicating that the model was able to distinguish between students whose performance were below a score of 50 and those whose scored 50 and above.

The model as a whole explained between

Table 2 : Independent Samples t-test

Exam score	Levene's test		t-test for equality of means						
			T	df	*p* value	Mean difference	SE of difference	95% CI	
	F	*p* value						Lower	Upper
Equal variances assumed	0.015	0.902	0.167	125	0.868	0.48	2.87	-5.20	6.15
Equal variances not assumed			0.167	124	0.867	0.48	2.85	-5.17	6.13

Note. df, degrees of freedom; SE, standard error; CI, confidence intervals.

46.4% (Cox and Snell R Square) and 64.8.0% (Nagelkerke R Square) of the variance in level of performance and correctly classified 86.6% of cases.

The Hosmer-Lameshow Test is the most reliable test of model fit produced by SPSS. A poor fit is indicated by a significance value *less* than 0.05 and to support the chosen model a significance value greater than 0.05 is required. In the model used, the Chi-Square value for the Hosmer-Lameshow Test was 8.220 with a significance level of 0.412. This value is greater than 0.05, which indicated a support for the model.

As shown in Table 3, only three of the independent variables made a unique statistically significant contribution to the model – 'hours of study allocated per week', 'able to complete assignments in time', and 'enough time given to complete examination'.

The strongest predictor for predicting level of performance was 'able to complete assignments in time', recording an odds ratio of 7.256. This can be interpreted as, students who were able to complete their assignments in time were nearly seven times more likely to fall in the '50 & above' performance category compared to those students who failed to complete assignments in time, controlling for all other factors.

The second strongest predictor was, 'enough time to complete the examination', for which the odds ratio was 3.599. This indicates that those who reported that they had enough time to complete the examination were about 3.6 times more likely to fall in the '50 and above'

performance category compared to those who reported not having enough time to complete the examination, controlling for all other factors.

The third strongest predictor was 'hours of study allocated per week to review the lessons' for which the odds ratio recorded was 3.212. This is interpreted as, for every additional hour of study per week, with all other factors controlled, a student is about 3.2 times more likely to fall in the '50 and above' performance category.

It is noted that the remaining three predictors, 'participation in group discussion', 'myLMS usage' and 'tutorial sessions sufficient or not' did not contribute significantly to the model.

The sensitivity of the model (Table 4) is the percentage of students who fell in the '50 and above' performance category (characteristics of interest) that has been accurately identified by the model. The model correctly classified 91.9% of the students whose level of performance fell in the '50 and above' performance category.

The specificity of the model (Table 4) is the percentage of students who fell in the 'below 50' performance category correctly identified by the model. In this case, the specificity as shown in the table was 75.6%, which is the percentage of students with performance below a score of correctly predicted by the model.

3.6 General Comments :

The module, Introduction to Statistics covers basic elements in Statistics, namely, descriptive statistics (frequency distribution, statistical diagrams, measures of central tendency, dispersion &

Table 3 : Variables in equation

Category	Odds ratios	95% CI		p value
		Lower	Upper	
Study hours	3.21	1.71	6.03	0.000
Complete Assignment in time	7.26	2.11	24.90	0.002
Enough exam time	3.60	1.10	11.79	0.034
Sufficient tutorials	0.99	0.31	3.17	0.986
Group participation	2.54	0.79	8.17	0.118
myLMS participation	1.12	0.36	3.44	0.844

Note. CI, confidence intervals.

Table 4 : Classification matrix: Performance level

Observed	Predicted		Percentage correct
	Performance level		
	Exam score <50	Exam score ≥50	
Exam score <50	31	10	75.6
Exam score ≥50	7	79	91.9
Overall percentage			86.6

skewness), elementary probability theory and probability distributions. One would expect that even a moderate amount of preparation would suffice to secure good results. Obviously, the overall performance with a mean score of 54.2 is not highly commendable. It is also noted that of the 127 students, 41(32.3%) obtained marks below 50 and only 16(12.6%) scored 75 and above.

What could be the plausible reasons for many of the students not achieving good grades in the subject?

Students should allocate a sufficient amount of time to review their lessons. Findings from the study showed that number of hours allocated by students per week to review their lessons was only 3.8 hours on the average, which obviously is insufficient to achieve good grades in the examination.

Secondly, group discussion is an important component in an online learning program. The findings from this study showed that only about 53% of the students who took Introduction to Statistics, participated in group discussions. The results are not very encouraging since, being ODL students, exchange of knowledge among one another will enhance their understanding on the topic and also the interaction process would serve as a motivation factor in the learning process.

Thirdly, only about a half of the students reported that they contacted their tutors whenever they encountered problems with their lessons. Among those who contacted the tutors, the number of contacts was 1.5 per week on the average.

Being ODL students, there were number of challenges they had to cope up with during the course of their study, which could have also affected their performance in the subject. Among the challenges

reported, the four main ones were, 'busy working schedule (89.7%)', 'study manual not easily understood(68.4%)', 'not able to interact with course mates(55.7%)', and 'disturbance from family members(42.1%). It is to be noted that students were allowed multiple choices on the question of 'challenges faced in coping up with their studies'.

As mentioned in section 3.5, students on the whole did not have any prior knowledge in statistics or e-learning experience before beginning their studies at the OUM. It was also observed that there was no correlation between age and overall performance in statistics.

Of the six predictor variables used in the model, logistic regression analysis revealed 3 significant predictors of performance of students in the subject who are likely to fall in the '50 & above' score category – 'able to complete assignment in time', 'enough time to complete the examination', and 'hours of study allocated per week'.

Students who are not able to complete the assignment in time are usually the weak students who wait until the last moment and end up submitting some shoddy work after the deadline. It is to be noted that a penalty (marks deducted) is imposed for late submissions.

Students who did not find enough time to complete the exam deprived themselves of achieving good results. For a quantitative module such as Statistics, a good amount of practice is required to develop the confidence to acquire the ability to complete the exam in the stipulated time.

The amount of time effectively spent to review the lessons has a positive relationship with the result a student would achieve in the examination. The model identified 'hours of study allocated per week' as one of the significant predictors on the likelihood of performance of a student falling in the '50 & above' score category and as mentioned above, for every additional hour of study allocated per week the performance of the student is about 3 times more likely to fall in the '50 & above' score category.

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