Factors influencing Progression Rate in Higher Education in Oman - Data Engineering and Statistical Approach

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Abstract—**The paper highlights key issues in student progression in a tertiary level educational system. The colleges operate under the ministry of higher education, ministry of men power. Private universities are affiliated with the external universities from the developed world. Students come from various backgrounds and allocation of students to the education system depends on the performance of the student in the school. The good students get placed in state universities and colleges and those who could not get in the state universities get placed in private universities and colleges. Progression rates in all the type of system is a challenge. We have addressed a way to overcome this problem in this paper. An attempt is made to analyze the factors influencing progression rate in higher education system via data engineering and statistical approach.**

Index Terms— Education System, Data Engineering, Progression Rate, Student Models, Learning Styles and Logistic Regression

I. INTRODUCTION

THE Tertiary educational system in Oman is undergoing revolutionary changes in the way it is administered. Oman is a young and vibrant economy and the government's emphasis on providing quality education to the young citizens of the country is leveraging the expertise and knowledge level of the next generation to face the competition and challenges emerging in the modern world[1].

The tertiary education in the country is divided into the

following levels –

- one autonomous body, the Sultan Qaboos University,
- five private Universities, at Sohar , Nizwa, Buraimi, Sharqiyah, Dhofar, Arab Open University, and the German university of technology and five Applied Science Colleges at Ibri, Nizwa, Rustaq, Sohar, Sur and Salalah[3].
- There are numerous Private Colleges operating in the Sultanate.
- Ministry of Manpower which is in charge of seven higher college of technology at Muscat , Nizwah Shenaz, Ibri,Ibra ,Salalah and Musannah
- A new university project, the Oman University for research is in the pipeline.

The *Omanuna* web system, allows students to register to the colleges under Ministry Of Higher Education [4].
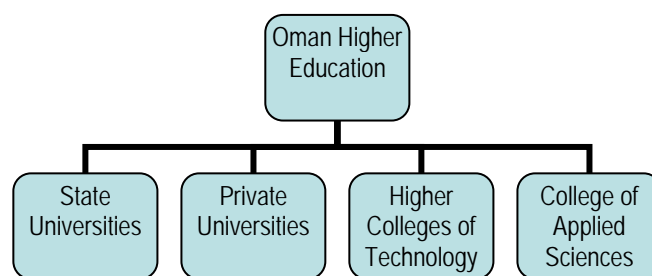

Fig. 1. - The Higher Education System in Oman

Students with higher grades are absorbed by SQU, and colleges operating under the Ministry of Higher Education and Ministry of Manpower.

Students select preferences and are granted admission depending on the systems' assessment of their application. Public institutions provide registered students with free education and a monthly stipend. A subset of these Ministry sponsored students also register in private institutions.

The programs offered in these colleges are being accredited by the Oman Academic Accreditation Authority (OAAA). OAAA is responsible for institutional accreditation (including Quality Audits and standards

assessment).

Program accreditation (including Foundation Program), quality enhancement, and maintaining the country's educational framework [4,5].

The Colleges of Technology under Ministry of Manpower use the central Students Management System for advising, online course registration, attendance recording, marks collation, results publication and other related academic activities.
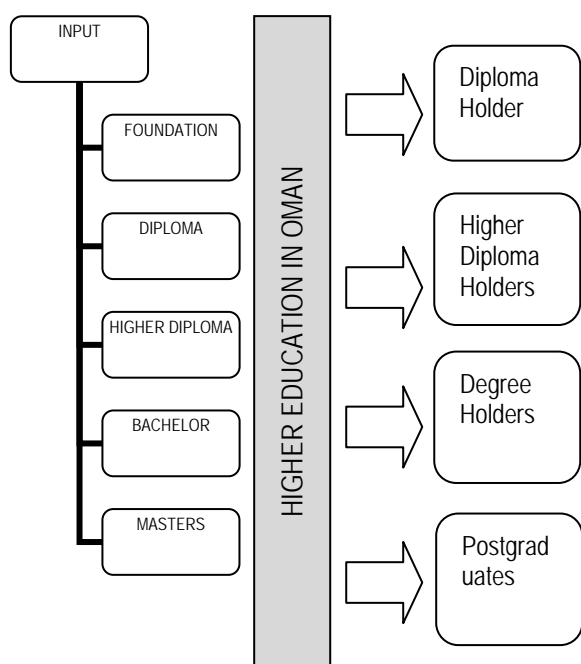

Fig.2. - The Higher Education Process – Graduate Progression

II. DATA COLLECTION PROCESS

At present, the data required for the study is not available for analysis in this paper. The authors hope to acquire the related data in due time to complete the required analysis.

Once the data collection process is complete the authors aim to study the relation between student progression rates from level to level in the three departments of the college.

The study will study the impact of the various factors discussed in Section IV to deduce the probability of students who will not have a successful progression rate. Another perspective will be to predict the number of students who will not successfully exit their probation periods.

III. PROBATION IN HIGHER EDUCATION COLLEGES

The college follows a system of student progression depending on the cumulated GPA. Continuous student assessment is carried out to assess the student's academic ranking, throughout their program. Bases on the assessment result, students are classified under the following sections.

Case 1.

Case 2. A student is accorded a "Good Academic Standing" if he or she maintains a cumulative GPA of 2.0 or higher.

Case 3. A student is placed on "Academic Probation" if his or her cumulative GPA falls below 2.0.

The colleges follow the system of academic probation in Case 2.

Students are classified into different groups depending on their annual semester performance. Students who fail to achieve a cumulative of 2, (GPA) Grade Point Average are placed under probation.

A student enrolled in the program must have a minimum cumulative Grade Point Average (GPA) of 2.0 to graduate from their program.

There are different strategies followed in universities and colleges with regards to such students,

- If the semester GPA is < 2, then the students will be put in probation. If they want to exit the probation their cumulative GPA and semester GPA must be greater than 2. If they are not exiting the probation by the third time, they will be exited from the program.

- Under the condition a student is still eligible for regular enrollment to the courses offered in the program. The student must now take concrete steps to exit probation. He will be advised to attend special workshops or programs in the college to perform to a higher level and achieve the target GPA. Some colleges may offer an opportunity to repeat certain courses and record the better grade for GPA purposes.

- A student will be given two chances – Probation 1 and Probation 2 and Probation 3 (College council has the right to consider rare cases where a student may need to be placed in this category) to achieve the stipulated GPA.

- A student may be suspended if the GPA remain below 2.0.Normally a student will then risk being in an academically unfavorable position after this time has elapsed, 'academic suspension'. Suspended students may not be allowed to enroll in classes for at least one term, and their financial aid may also be affected. In some colleges the students may be forced to drop out of the program if they do not fare well.

- In some colleges, students who believe they have reason to appeal for exit from probation may have to sit a a special academic board to get approval to continue their studies in the enrolled program.

Colleges around the world use probation to give a timely caution to enrolled students, who are not performing well to help them perform well by reducing their academic load and by constraining these students to enroll for a limited number of courses from the set of courses in their chosen program schedule.
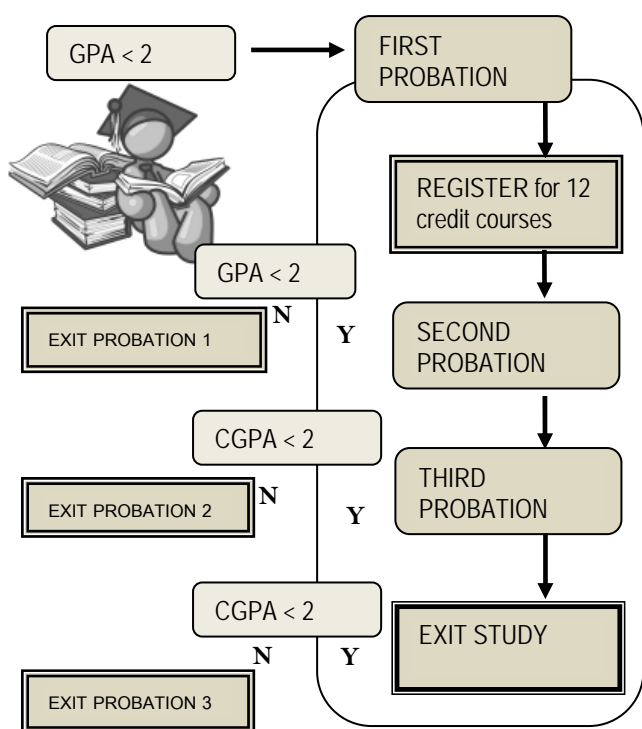
Fig 3 –Student Probation System

. Students under probation are advised on the means by which they can exit probation.

- A student will be placed under academic probation 1st Probation, if his/her GPA is less than 2 in any semester.
- Academic probation expires at the end of each semester, when the student obtains a minimum CGPA of 2.
- If the student does not satisfy the conditions for the expiry of 1st Probation, he would be placed in the 2nd Probation & so on to 3rd Probation in the following semesters.
- During the probation period, he/she will be allowed to register for only 4 courses with a maximum of 12 credit hours.

These include:
- Repeating the failed courses.
- Changing courses (majors) and select courses (majors) that might help to achieve a better cumulative GPA

- Registering for a reduced course load

IV. REGRESSION MODEL

A logistic regression model allows us to establish a relationship between a dichotomous outcome variable and a group of predictor variables. Odds are the probability of an event occurring divided by probability of the event not occurring.

$$\text{Odd} = \frac{P(event)}{1 - p(event)}$$

In logistic regression, dependent variable is a logit, which is the natural log of odds. .It models the logit-transformed probability as a linear relationship with the predictor variables. Let **X1**, .., **Xk** be a set of predictor variables. Then the logistic regression of **Y** on **X1**... **Xk** estimates parameter values for $\beta_0, \beta_1, \ldots, \beta_k$ via maximum likelihood method of the following equation[2].

$$\textbf{Logit (P)} = \ln\left[\frac{p(event)}{1 - p(event)}\right] = {}^{(\beta_0 + \beta_1 X_1 + \ldots + \beta_k X_k)}$$

or

If we want to analyze a relationship between dichotomous outcome variable and metric or categorical independent variable, then logistic regression can be used.

Logistic Regression Formula can be redefined as or modified as,

$$P(Y) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon_i)}}$$

P(Y) = Probability of Y occurring

X1, X2 …are independent predictor variables

e is the base of natural logarithm

Y is the dichotomous outcome variable and this will be given weights:

Progression Successful (Yes will be assigned, value 1)

Progression Failure (No will be assigned value 0)

$\beta 1$ and $\beta 2$ are the coefficients of independent predictor variables $X_1, X_2, \ldots X_K$

ε_i is a residual term

Most of the statistical software also provide exponentiated logistic coefficient which is antilog transformation of the original logistic coefficient. The sign of the original coefficients positive or negative indicates that the direction of the relationship. A positive coefficient increase the probability, where as a negative value decreases the predicted probability. But the exponentiated coefficients above 1 reflect a positive relationship and value less than I represent a negative relationship.

TABLE I

STUDENTS PROGRESSION BETWEEN SEMESTERS IN A TERTIARY EDUCATION
INSTITUTE IN OMAN

Faculty		Computer Science				
Level	20101	20102	20111	20112	20121	20122
Diploma	335	338	385	402	555	595
Advanced	34	40	40	32	44	53
Bachelor	22	24	25	33	30	23
Grand Total	391	402	450	467	629	671

Faculty		Engineering				
Level	20101	20102	20111	20112	20121	20122
Diploma	744	750	674	676	794	820
Advanced	75	89	118	110	92	85
Bachelor	35	37	47	61	77	83
Grand Total	854	876	839	847	963	988

Faculty		Business				
Level	20101	20102	20111	20112	20121	20122
Diploma	373	357	351	390	602	676
Advanced	53	57	50	38	38	36
Bachelor	17	21	33	47	31	31
Grand Total	443	435	434	475	671	743

Goodness of Fit

The goodness of fit for a logistic regression can be checked by measuring log-likelihood statistic and its associated χ^2 statistics.

$$\log-likelihood = \sum_{i=1}^{N}[Y_i \ln(P(Y_i)) + (1-Y_i)\ln(1-P(Y_i))]$$

P(Yi) is probability that Y occurs for the ith case, Yi is the actual outcome for the ith case.

A large value of the log likelihood statistic indicates poorly fitting statistical model and on the other hand if the likelihood value is small, then the model that fits the data well .

We can compare log likelihood (LL) for different models and by looking the difference between the LL values. If the null model is one without any independent variable and the new model is with one or more independent variable, then we can compute the improvement of the model as follows

$$\chi^2 = 2[LL(New) - LL(Null)]$$ with degree of freedom

(d.f)= number of parameters in the new model minus the

(Number of parameter in the null model.

TABLE II
UNITS FOR CONSTRUCTING THE STUDENT MODEL

SYMBOL	VARIABLE
English Scores	X1
Employment Status (Yes= 0 and No=1)	X2
Marital Status (Married=0 and Unmarried =1)	X3
Attendance	X4
Mathematics Scores	X5

Wald statistic can be used to check the significance of the β coefficients. If the logistic coefficient is statistically significant, we can interpret it in terms of how it impacts the estimated probability and thus the prediction of the group membership.

$$\text{Wald} = \frac{\beta}{SE_\beta},$$

β is the logistic regression coefficient and SE$_\beta$ is the associated standard error.

The experiment will consist of inferring factors for these values in Table1.

In our research problem, outcome variable is Progression which we can classify as Yes with value 1 and No with value 0. We have selected the following factors that will impact the progression rate of students from one level to another [7].

Logistic regression does not require any assumption of normality, linearity and homogeneity of variance for the independent variable. But we have to check the multi co-linearity of independent variables.

We propose to use suitable statistics software to verify our hypothesis

V. LEARNING STYLES FOR SMOOTH PROGRESSION

The students are viewed as the individuals involved in the learning activities which involve theoretical knowledge, practical and implementation of the learned knowledge,

but at the same time progression should be maintained from the foundation to the faculty courses. Here emphasis should be given on learning styles. The school and university education systems requirement are different [8].

Learning emphasis is based on the skill set which students acquire during theoretical lectures, tutorial classes and in the lab sessions. The knowledge gain is acquired through various techniques like grasp of concept, illustration and implementation of the concept using various information technology tools like the internet, e-mail, World Wide Web (www) for information, communication and education (IEC)[9, 10].
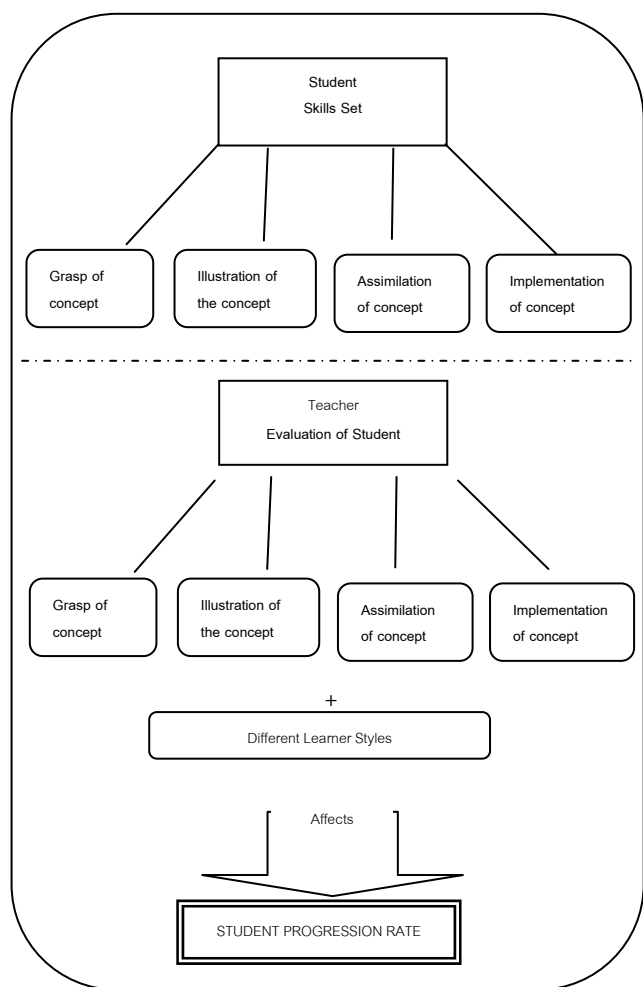

Fig. 1. - The Higher Education System in Oman

Some of the basic principles for smooth progression are:
- Learning must be targeted for acquiring the latest knowledge in the given field of study.
- Appropriate Sequencing of Instruction must be done for active learning.
- Active Student's Involvement and keeps responsibility with the student.
  - Feedback on Performance must be monitored.

It is observed that students learn and understand better if they are motivated and can fit their learning into a learning framework [11, 12].

Modeling and testing of such e-learning systems are complex and difficult task, still it is suggested that based on the data and progression rate the learning styles must be emphasized[14, 15].

Sequence of learning can progress from in the following manner[18]:
- Simple to hard and then to complex.
- Known domain to unknown domain
- Example to principle
- Concrete to abstract

Analytical learning [20] is the suggested approach for the better and smooth progression.

1. Analytical learning is based on principles and rules and it is very clear, precise and accurate.

2. Exception always exists and analytical learner some time don't make rules and if there is situation where rules don't fit in place

3. Categorizing information which helps to recall the information when they needed is the best feature in analytical learning.

TABLE III
LEARNING MODELS AND PARAMETERS

Models	Parameters
Adaptation	*Learner profile is created and resources for learning are arranged according to the adaptation techniques suggested by Artificial intelligence.*
Personalization	*Complementary personalization levels must be adapted and customization must be done.*
User Modelling	*Automatic Detection of learning behaviors and styles, Vector space models for user modeling.*
Content Model	*Open Content Object model is also used in learning.*

TABLE IV
LEARNING MODES AND IMPACT ON PROGRESSION

Mode of Learning	Impact
Collaboration with peers	Communication between peers and experience is gathered with experience, discussion and information sharing and negotiation.
Systems Mediated Learning	Learning management systems is used for knowledge exchange and communication purposes. From the usage of LMS it increases the opportunity for collaborative and interactive Learning in the student community.
Discussion and Bulletin Boards	Analysis, integration and assessment is carried out with maximum efficiency.

VI. RESULT

Using the factors from Table II we analyzed the data from a tertiary institute. We checked the multi co linearity and checked the significance of the model, we got the following result.

TABLE V
OUTPUT OF ANALYSIS

	B	Wald	df	Sig.	Exp(B)
English score	.084	4.206	1	.040	1.088
Employed(1)	2.935	5.535	1	.019	18.816
Marital status(1)	2.762	5.420	1	.020	15.835
Constant	-9.369	7.268	1	.007	.000

The results in the table can be interpreted as follows, the value of Exp(B) for

- English score indicates that one unit change in English Score will increase the progression by 8.8%, keeping other variables constant.
- Employed is 18.816, i.e. one unit change in employment status from employed to unemployed will affect the progression by 18 times, i.e. employment leads to drop in progression.
- Marital Status is 15.835. i.e. one unit change in marital status from married to unmarried will lead to increase the progression by 15 times.

VII. CONCLUSION

Progression rate is very important concern in the state sponsored education system. Students have to perform according to the standards decided by the higher education accreditation system. The learning outcomes of the programs are decided to evaluate the students' performance.

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