CONSTRUCTION OF MATHEMATICAL MODELS IN LANGUAGE LEARNING STRATEGY AND ENGLISH PROFICIENCY OF PRE-UNIVERSITY STUDENTS

JOHANNAH BINTI JAMALUL KIRAM

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

FACULTY OF SCIENCE AND NATURAL RESOURCES
UNIVERSITI MALAYSIA SABAH
2016

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN STATUS TESIS

JUDUL: CONSTRUCTION OF MATHEMATICAL MODELS IN LANGUAGE LEARNING STRATEGY AND ENGLISH PROFICIENCY OF PRE-UNIVERSITY STUDENTS

IJAZAH: SARJANA SAINS

Saya, **JOHANNAH BINTI JAMALUL KIRAM** Sesi Pengajian 2013-2015 mengaku membenarkan tesis Sarjana ini disimpan di Perpustakaan Universiti Malaysia Sabah dengan syarat-syarat kegunaan seperti berikut:-

1. Tesis ini adalah hak milik Universiti Malaysia Sabah.
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagain bahan pertukaran antara pengajian tinggi.
4. Sila tandakan (/)

☐ SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐ TERHAD (Mengandungi Maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☑ TIDAK TERHAD

Disahkan oleh,

(Tandatangan Pelajar)

NURULAIN BINTI ISMAIL
LIBRARIAN
UNIVERSITI MALAYSIA SABAH
(Tandatangan Pustakawan)

Alamat Tetap: No. 5, Lorong Aman 2,
Taman Aman, 88450
Kota Kinabalu, Sabah.

Tarikh: 25 Febuari 2016

(PROF. MADYA DR. JUMAT SULAIMAN)
Penyelia

DECLARATION

I hereby declare that the material in this thesis is my own except for quotations, equations, summaries and references, which have been duly acknowledged.

Date: 4 MARCH 2016

.....

Johannah Binti Jamalul Kiram
MS1311005T

CERTIFICATION

NAME : **JOHANNAH BINTI JAMALUL KIRAM**

MATRIC NO. : **MS1311005T**

TITLE : **CONSTRUCTION OF MATHEMATICAL MODELS IN LANGUAGE LEARNING STRATEGY AND ENGLISH PROFICIENCY OF PRE-UNIVERSITY STUDENTS**

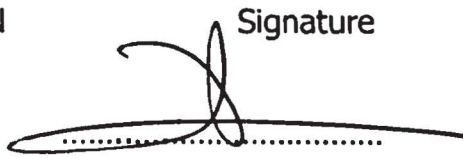
DEGREE : **MASTER OF SCIENCE (MATHEMATICS)**

VIVA DATE : **27 JANUARY 2016**

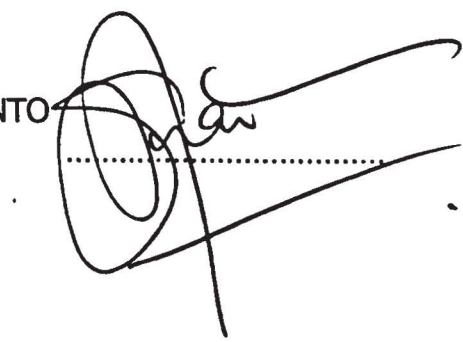
DECLARED BY

1. MAIN SUPERVISOR
ASSOCIATE PROFESSOR DR. JUMAT SULAIMAN

Signature



2. CO SUPERVISOR
ASSOCIATE PROFESSOR DR. SUYANSAH SWANTO



ACKNOWLEDGEMENTS

First and foremost, Alhamdulillah. I would like to express my sincere thanks to those who have helped me throughout my study in Universiti Malaysia Sabah.

My deepest gratitude goes to my supervisors, Assoc. Prof. Dr. Jumat Sulaiman and Assoc. Prof. Dr. Suyansah Swanto for their never ending support, guidance and continuous encouragement throughout the course of my study.

Special thanks goes to Puan Wardatul Akmam Din for helping me with gathering the data. May Allah bless her.

Lastly, for my family. To my parents, for the understanding and support. To my husband, Awang Mohamad Yazrif, thank you for always being by my side through good times and hard times.

Johannah Binti Jamalul Kiram
MS1311005T

ABSTRACT

This study aims to construct the best mathematical model that describes the relationship between six Language Learning Strategies and English proficiency of the pre-university students of Universiti Malaysia Sabah. Two hundred and thirty pre-university students of Universiti Malaysia Sabah took part in this study by answering a background questionnaire and the Strategy Inventory for Language Learning self-report questionnaire. Also, these students sat for the Malaysian University English Test (MUET) and their results are taken as the student's proficiency in English as a second language. Three linear regression models was used as initial models, two of which went through stepwise variable selection method. However, in this study, we proposed two families of nonlinear models, which are the nonlinear Gompertz model, and a modified Gompertz model. Based on the five proposed models, the dependent variable, y, is the normalized English proficiency of the students and the independent variables, X_j, are the six different language learning strategies where $j = 1, 2, 3, \ldots, 6$. These six strategies are memory, cognitive, comprehensive, metacognitive, social and affective respectively. Goodness-of-fit tests and information criterion were used to assess these models, which are the root mean square error (RMSE), mean absolute error (MAE), residual standard error (RSE), the corrected Akaike information criterion (AIC_C) and Bayesian information criterion (BIC). The results were then used to compare these models. The linear model showed good readings with its RMSE, MAE and RSE approaching zero indicating that the model is strong. However, the Gompertz model and the modified Gompertz model showed even better values of RMSE, MAE, RSE and AIC_C. Especially for the modified Gompertz model, the values for the errors were even closer to zero. The goodness-of-fit tests and AIC_C show that the modified Gompertz model's results were better than the nonlinear Gompertz model, and the linear regression model. Despite that, only the BIC calculated for the linear model M35 has the weightiest amount of information. In conclusion, four out of five metrics calculated suggested that the modified Gompertz model is the best amongst investigated models.

ABSTRAK

PEMBINAAN MODEL MATEMATIK DALAM STRATEGI PEMBELAJARAN BAHASA DAN PENGUASAAN BAHASA INGGERIS DIKALANGAH PELAJAR PRA-UNIVERSITI

Kajian ini bertujuan untuk membina model matematik terbaik yang mengilusinasikan hubungan antara enam strategi pembelajaran bahasa dan penguasaan bahasa Inggeris di kalangan para pelajar pra-universiti di Universiti Malaysia Sabah. Dua ratus tiga puluh pelajar pra-universiti di Universiti Malaysia Sabah telah mengambil bahagian dalam kajian ini dengan menjawab soal selidik latar belakang dan soal selidik laporan diri inventori strategi pembelajaran bahasa. Kemudian, pelajar tersebut ini menduduki Ujian Bahasa Inggeris Universiti Malaysia (MUET) dan keputusan mereka direkod sebagai penguasaan pelajar dalam bahasa Inggeris sebagai bahasa kedua. Tiga keluarga model regresi linear dipertimbangkan sebagai model-model awal. Walau bagaimanapun, kajian ini juga mengusulkan dua lagi keluarga model tak linear iaitu model Gompertz dan model Gompertz terubahsuai. Berdasarkan kelima-lima model yang dipertimbangkan, pembolehubah bersandar, y, adalah tahap penguasaan bahasa Inggeris pelajar, manakala pembolehubah tidak bersandar pula, X_j, $j = 1, 2, 3, \ldots, 6$, adalah enam strategi pembelajaran bahasa yang berbeza iaitu memori, kognitif, komprehensif, metakognitif, afektif dan sosial. Ujian kebagusan penyuaian model terbaik dan kriteria maklumat telah digunakan untuk menilai kelima-lima model tersebut, iaitu punca min ralat kuasa dua (RMSE), min modulus ralat (MAE), ralat reja piawai (RSE) kriteria maklumat Akaike diperbetulkan (AIC_C), dan kriteria maklumat Bayesian (BIC). Selanjutnya, keputusan ini digunakan untuk membandingkan model-model ini. Keputusan RMSE, MAE dan RSE untuk model linear menunjukkan keputusan yang baik di mana ia menghampiri sifar, mengesahkan bahawa ia sebuah model yang baik. Walau bagaimanapun, model Gompertz dan model Gompertz terubahsuai menunjukkan bahawa keputusan RMSE, MAE, RSE dan AIC_C yang lebih baik berbanding dengan model-model linear. Khususnya bagi model Gompertz terubahsuai, keputusan ujian ralat lebih menghampiri sifar. Ujian penyuaian model terbaik telah menunjukkan bahawa keputusan model Gompertz terubahsuai adalah yang terbaik berbanding model Gompertz dan model linear. Walaubagaimanapun, hanya BIC yang telah dinilai untuk model linear M35 menunjukkan bahawa model ini mempunyai ketumpatan maklumat yang banyak. Walaupun sebegitu, empat daripada lima metrik yang dinilaikan dalam kajian ini mencadangkan bahawa model Gompertz terubahsuai adalah model terbaik berbanding semua model yang dikaji.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIXES

LIST OF ABBREVIATIONS

AIC_c	The Corrected Akaike's Information Criterion
ANNs	Artificial Neural Networks models
BIC	Bayesian's Information Criterion
FL	Foreign languages
L2	Second language
LLS	Language Learning Strategy
MAE	Mean Absolute Error
MLR	Multiple Linear Regression
MUET	Malaysian University English Test
OLS	Ordinary Least Square
RMSE	Root Mean Square Error
RSE	Residual Standard Error
SILL	Strategy Inventory for Language Learning strategies
VIF	Variance Inflation Factor

LIST OF SYMBOLS

β_j	Unknown parameters
$\widehat{\beta_j}$	Estimated parameters
σ^2	Variance
μ_i	Random error
Y_i	Independent variable
X_i	Dependent variable
e	Exponential
n	Sample size
k	The number of independent variables
L	Maximum likelihood
Y_η	The normalized data of Y
K	Number of parameters in the model, including the intercept and L
X_{i1}	Memory strategy
X_{i2}	Cognitive strategy
X_{i3}	Comprehensive strategy
X_{i4}	Metacognitive strategy
X_{i5}	Affective strategy
X_{i6}	Social strategy
$\widetilde{X}$	$[X_{i1}\ X_{i2} \dots X_{i6}]^T$

N	Number of possible models
k	Number of independent variables
H_o	Null hypothesis
H_1	Alternative hypothesis
$\overline{Y}$	Mean of dependent variable
$\widehat{Y_\eta}$	Estimated dependent variable

CHAPTER 1

INTRODUCTION

1.1 Malaysian Education System and Language Learning Strategy

The Malaysian education system has always been ever changing to bring improvement across the country, regardless of those living in rural areas or in the urban areas. According to Zakaria (2000), the Malaysian national education system was established when Malaysia (then Malaya) gained its independence from the British and was modeled based on the English grammar school system of the British colonial era. However, throughout the years, Education Acts have been introduced from time to time to create an education system based on our national philosophies which is a centralized system with a common curriculum using Bahasa Malaysia as its main medium of instructions (Zakaria, 2000). As a step towards taking care of aspirations and sensitivities of Malaysia's multiethnic population, Chinese and Tamil schools are allowed to be established up to primary level education (Zakaria, 2000). However, the implementation of language learning strategies in English language into the education system has been vague as there are hardly any documented records of this (Wong, 2005).

English is considered the country's second language (L2) where it is a compulsory subject taught throughout primary and secondary schools in its formal education system. At a pre-university level, it is compulsory for those who plan to continue their studies at any Public Higher Educational Institutions (IPTA), as it is a pre-requisite for these students to take the Malaysian University English Test (MUET) prior to enrolment for their first degrees ("Bajet 2015." 2015). However, despite having English language taught in primary and secondary schools for at least eleven years, an average Malaysian student still finds it hard to master the language adequately especially in terms of verbal fluency, writing compositions in English and also applying proper grammar. This is causing problems, academically,

for students to get further education, moreover when most public and private universities in Malaysia now set English as their main language for most courses as an advantage for students to gain information and all sorts of different knowledge easily because they are mostly written in English. This greatly influences the student's future and the Malaysian's Vision 2020 where the nation achieves the status of a fully developed and industrialised country.

Over the years in the language-learning world, a system called the Language Learning Strategy (LLS) was introduced and highly researched on up until today. This system is focused on strategies that are used when learning a second language (L2) and foreign languages (FL). A number of types of strategies were introduced, as it will be further discussed in Section 2.2. However, as Wong (2005) reported in her study that in literature, there are hardly any documented records of local studies on English as a second language and the language learning strategies used in the Malaysian education system. A recent literature by Teh *et al.* (2009) was done to examine the relationship between the use of language learning strategies and language learning motivation, but it was for the Arabic language among students from Malaysia religious secondary schools students. This study chose to introduce another strategy called the "metaphysic strategy", as an addition to Oxford's (1990) Strategy Inventory for Language Learning strategies (SILL), which are memory strategy, cognitive strategy, compensation strategy, metacognitive strategy, social strategy and affective strategy. The study found that motivation level affects language learners is such a way that the higher it is, the richer the repertoire of strategies and the more frequently they employ strategies than less motivated language learners (Teh *et al.* 1990).

The Malaysian education system recently introduced English as a medium of instruction in schools starting in the year 2003. However, as of 2012, the medium of instruction has since been reverted back to the Malay language. This has brought many debates amongst linguists and activists, not forgetting politicians. In fact, the Sultan of Johor, Sultan Ibrahim Ibni Almarhum Sultan Iskandar expressed his concerns as to why English should have remained the main medium of instruction in schools through the news reported by The Straits Times, Singapore ("The sad state of English in Malaysia," 2015). Hence, this leaves limited options as

to who should be held to take the responsibility to improve the English proficiency of our students, as parents who started their education after the year 1970 (Puteh and Sintok, 2012), has faced little exposure to the language when the government decided to make the Malay language as the main medium of instruction. As a step forward, researches as to how to improve the practice towards the language should be taken, so despite the limited exposure towards the language, the impact of the knowledge gives obvious results in these pupils' language learning process. As cited in Park (1997), in order for L2 learners to be come autonomous learners who take charge of their learning, they must use appropriate language learning strategies (Wenden, 1991). Thus, putting as much effort to aid those in the pedagogical practice to improve the English language proficiency amongst pupils is highly recommended. Introducing the existence of language learning strategies into the system should be the step forward that needs to be taken, not only among students, but also towards present and future educators of any languages.

1.2 English Language Proficiency in Malaysia

According to The Malay Mail ("Malaysians most English proficient in Asia, ahead of Singaporeans, survey claims," 2015), a survey was done and Malaysia tops the survey as the most English proficient country in Asia. However, worldwide, Malaysia is only ranked at number twelve ("EF English Proficiency Index," 2015). These claims were made out of a survey that also said the survey index was self-selected and not guaranteed to represent the whole country, which was administered online. Thus, limiting their sample size to only those who are frequent Internet users and excluding those in rural areas, those that are not interested in taking tests via the Internet, and those with limited source for connecting to the Internet.

However, since these claims were made out of bias data, it is unfair to conclude entirely the state of English proficiency in Malaysia. In fact, Pandian (2002) stressed the concern among teachers, scholars and the members of public about how the proficiency of English amongst students has declined since the implementation of the Malay medium of instruction. Not only will this effect a student's admission to institutions of higher learning, but also occupational needs in the industry (Abdullah, 2012). In addition to this, the government has made a

number of initiatives to help solve the problems. Amongst which was the 10-year period from 2003 to 2012 of when English was made the main medium of instruction in primary and secondary school for the Science and Mathematics subjects. However, this initiative was reverted back as many linguists and activist disagrees with the system, afraid that these students will lose their interest towards the National language of Malaysia. Another initiative of the Malaysian government was announced by the Former Deputy Prime Minister of Malaysia, Tan Sri Muhyiddin Yassin on the 8th of March, 2013, where it has been decided that English language will be a compulsory pass subject in the Malaysian Certificate of Education (SPM) starting 2016 ("Muhyiddin: English a compulsory pass subject as early as 2016," 2015). This is in hopes that it will make students realize the importance of English language before entering into their first degree due to the fact that most medium of knowledge these days are written in English.

As one of the stepping stone on how to make studying L2 easier, this study is important to ensure that those in the pedagogical practice will be more certain about their approaches on how to instill more knowledge about the English language among their students. Recognizing a student's main strengths and weaknesses when it comes to language learning should be the initial move. This study aims to recognize how, as a whole, each of the language learning strategies aid these students of Universiti Malaysia Sabah in achieving better proficiency. After all, each of these strategies introduced by Oxford (1990) are according to the norm of language learning world. Thus, analyzing their ways in using these strategies will give an advantage to the educators as to how to give these students a more influential learning system.

1.3 Language Learning Strategies

This Section discusses the strategies that are used throughout this study. The context of this study portray, language learning strategy (LLS) is a type of learning process which involves actions, practice and interactions that are consciously utilized with the intentions of improving a learner's ability to grasp a certain language. Using Oxford's (1990) concept introduced in the book "Language Learning Strategy: What Every Teacher Should Know", this study focuses on the

relationship between these strategies and the outcome of their language proficiency.

Oxford (1990) introduced six strategies, each with its specific definition. These strategies were divided into two; direct and indirect strategies, for which the book defined and showed their applications to develop four skills which are reading, writing, listening and speaking. Direct strategies are LLS that directly involve the target language such as memory, cognitive and compensation strategies, whereas indirect strategies are strategies that support and manage the language learning without directly involving the target language, such as metacognitive, social, and affective strategies (Oxford 1990).

Oxford (1990) defined these strategies short and precise using diagrams. It was said that;

i. Memory strategy is creating mental linkages, applying images and sounds, reviewing well and employing action.
ii. Cognitive strategy is practicing the language, receiving and sending messages, analyzing and reasoning, and creating structure for input and output.
iii. Compensation strategy is guessing intelligently and overcoming limitations in speaking and writing.
iv. Metacognitive strategy was described as centering your learning, arranging and planning your learning, and evaluating your learning.
v. Affective strategy is lowering your anxiety, self-encouraging, and taking your emotional temperature.
vi. Social strategy is asking questions, cooperating with others, and empathizing with others.

According to previous studies of LLS at a university level (Park, 1997; Wharton, 2000; Nisbet *et al.*, 2005; Hong Nam and Leavel, 2006; McMullen, 2009; Ghavamnia *et al.*, 2011), these strategies have been examined to be closely related to the language proficiency of the targeted students. In addition to that, this study focusses on on how a pre-university student in Universiti Malaysia Sabah utilizes all

six strategies and how it affects their language proficiency where the results can be used to analyze which strategy actually strengthens a student's language proficiency. As a result, both the English language education world and the research on LLS can be understood. Studies of the different movements and strategy used from students around the world is seen through researches from Korea (Park, 1997), China (Nisbet *et al.,* 2005), Saudi Arabia (McMullen, 2009) and Botswana (Magogwe and Oliver, 2007). By referring to the previous statement, this could be a stepping-stone for researchers in Malaysia to go more in depth as to what makes a better language learner. Inspired by previous results, the same concept of study will be conducted to examine the LLS of the pre-university students, specifically from Universiti Malaysia Sabah.

1.4 Development of Mathematical Models

Mathematical models are a perception of reality. A single line of mathematical symbols and numbers may represent a number of things. When a mathematical model is done right, it will help to understand the system in a better way, and predict outcomes subject to its accuracy. To build a mathematical model, there has always been a system to follow. Beginning from the raw data up until its results, there are always tests and observations that need to be done.

Figure 1.1 is an adaptation from Archontoulis and Miguez (2015), where it was simplified to keep it within the scope of this discussion. It shows a diagram of steps to follow when building a mathematical model. It begins with raw data. To check for outliers, errors, and assumptions of a certain type of distribution, the discussion begins with graphs and plots such as quantile-quantile plots, histograms, scatter plots and residual plots. From the observations of the plot, the decision as to remove the outliers or to consider generalized linear models, which are models with errors that do not follow normal distributions, is to be considered. Then, determining the type of model the data might fit into is next. To build a nonlinear mathematical model, it will always have starting values because models are not guaranteed to converge to the global optimum. Thus, starting values are needed to begin estimation of the parameters. The starting values need to be obtained or dealt with by stating assumptions. However, in this study, the nonlinear model will

REFFERENCES

Abdullah, K. I. 2012. English for Specific Purpose in Malaysia: International Influence, Local Flavour. *Journal of Southeast Asian Education.* **2**(2):345-361.

Abraham, A. 2005. Artificial neural networks. *Handbook of Measuring System Design.* **8**(3):129.

Adhikari, R. and Agrawal, R. K. 2013. An Introductory Study on Time Series Modeling and Forecasting. *arXiv preprint arXiv:1302.6613.*

Ahad, N. A., Yin, T. S., Othman, A. R., and Yaacob, C. R. 2011. Sensitivity of normality tests to non-normal data. *Sains Malaysian*, **40**(6):637-641.

Akaike, H., 1973. Information theory as an extension of the maximum likelihood principle. sin: Petrov BN, Csáki F (eds). *Second international symposium on information theory. Akadémiai Kiadó, Budapest*, 267–281.

Ali, M. K. M., Ruslan, M. H., Muthuvalu, M. S., Wong, J., Sulaiman, J., and Yasir, S. M. 2014. Mathematical modelling for the drying method and smoothing drying rate using cubic spline for seaweed Kappaphycus Striatum variety Durian in a solar dryer. In *American Institute of Physics Conference Series.* **1602**:113-120.

Archontoulis, S. V., and Miguez, F. E. 2015. Nonlinear regression models and applications in agricultural research. *Agronomy Journal*, **107**(2):786-798.

Bajet 2015. (n.d.). Retrieved June 7, 2015, from http://www.hasil.gov.my/pdf/pdfam/ub15.pdf.

Baranyi, J., and Roberts, T. A. 1994. A dynamic approach to predicting bacterial growth in food. *International journal of food microbiology*, **23**(3):277-294.

Baranyi, J., Robinson, T. P., Kaloti, A., and Mackey, B. M. 1995. Predicting growth of Brochothrix thermosphacta at changing temperature. *International journal of food microbiology*, **27**(1):61-75.

Baranyi, J., Csernus, O., and Beczner, J. 2014. Error analysis in predictive modelling demonstrated on mould data. *International journal of food microbiology.* **170**:78-82.

Bates, D. M., and Watts, D. G. 2007. *Nonlinear regression analysis and its application, Wiley Ser. Probab. Stat.* New York: John Wiley and Sons.

Baty, F., Ritz, C., Charles, S., Brutsche, M., Flandrois, J. P., and Delignette-Muller, M. L. 2014. A toolbox for nonlinear regression in R: the package nlstools. *at the Journal of Statistical Software.* **66**(5):1-21.

Becker Jr, W. E. 1983. Economic education research: Part III, statistical estimation methods. *The Journal of Economic Education.* **14**(3):4-15.

Bhaduri, S., Smith, P. W., Palumbo, S. A., Turner-Jones, C. O., Smith, J. L., Marmer, B. S., Buchanan, R. L., Zaika, L. L., and Williams, A. C. 1991. Thermal destruction of Listeria monocytogenes in liver sausage slurry. *Food Microbiology.* **8**(1):75-78.

Bloomfield, P. 1973. An exponential model for the spectrum of a scalar time series. *Biometrika.* **60**(2):217-226.

Bolboacă, S. D., and Jäntschi, L. 2008. Modelling the property of compounds from structure: statistical methods for models validation. *Environmental Chemistry Letters.* **6**(3):175-181.

Brass, W. 1975. *Methods for estimating fertility and mortality from limited and defective data.* Chapel Hill : Laboratories for Population Statistics at the University of North Carolina at Chapel Hill.

Breusch, T. S., and Pagan, A. R. 1979. A simple test for heteroscedasticity and random coefficient variation. *Econometrica: Journal of the Econometric Society.* 1287-1294.

Bremner, S. 1999. Language learning strategies and language proficiency: Investigating the relationship in Hong Kong. *Canadian Modern Language Review.* **55**(4):490-514.

Bretthorst, G. L. 2013. *Bayesian spectrum analysis and parameter estimation* (Vol. 48). Heidelberg:Springer Science & Business Media.

Buchanan, R. L., and Phillips, J. G. 1990. Response surface model for predicting the effects of temperature pH, sodium chloride content, sodium nitrite concentration and atmosphere on the growth of Listeria monocytogenes. *Journal of Food Protection®.* **53**(5):370-381.

Buchanan, R. L., Whiting, R. C., and Damert, W. C. 1997. When is simple good enough: a comparison of the Gompertz, Baranyi, and three-phase linear models for fitting bacterial growth curves. *Food Microbiology.* **14**(4):313-326.

Burnham, K. P., and Anderson, D. R. 2002. *Model selection and multimodel inference: a practical information-theoretic approach.* Springer Science & Business Media.

Burnham, K. P., and Anderson, D. R. 2004. Multimodel inference understanding AIC and BIC in model selection. *Sociological methods & research.* **33**(2):261-304.

Castillo, E., and Gutiérrez, J. M. 1998. Nonlinear time series modeling and prediction using functional networks. Extracting information masked by chaos. *Physics Letters A.* **244**(1):71-84.

Chai, T., and Draxler, R. R. 2014. Root mean square error (RMSE) or mean absolute error (MAE)?–Arguments against avoiding RMSE in the literature. *Geoscientific Model Development.* **7**(3):1247-1250.

Chalmond, B., and Girard, S. C. 1999. Nonlinear modeling of scattered multivariate data and its application to shape change. *Pattern Analysis and Machine Intelligence, IEEE Transactions on,* **21**(5):422-432.

Chin, W. W. 1998. The partial least squares approach to structural equation modeling. *Modern methods for business research.* **295**(2):295-336.

Cohen, J., Cohen, P., West, S. G., and Aiken, L. S. 2013. *Applied multiple regression/correlation analysis for the behavioral sciences 3rd edition.* New Jersey: Routledge.

Coughlin, S. S., Trock, B., Criqui, M. H., Pickle, L. W., Browner, D., and Tefft, M. C. 1992. The logistic modeling of sensitivity, specificity, and predictive value of a diagnostic test. *Journal of clinical epidemiology.* **45**(1):1-7.

Data normalization and standardization. (n.d.). Retrieved 24 January, 2015 from http://www.benetzkorn.com/wp-content/uploads/2011/11/Data-Normalization-and-Standardization.pdf.

DeMaris, A. 2004. *Regression with social data: Modeling continuous and limited response variables* (Vol. 417). New Jersey: John Wiley & Sons.

Draper, N. R., Smith, H., and Pownell, E. 1966. *Applied regression analysis* (Vol. 3). New York: Wiley.

Durbin, J., and Watson, G. S. 1950. Testing for serial correlation in least squares regression. I. *Biometrika*. **37**(3-4):409-428.

Egghe, L., and Ravichandra Rao, I. 1992. Classification of growth models based on growth rates and its applications. *Scientometrics*. **25**(1):5-46.

EF English Proficiency Index. (n.d.). Retrieved 24 June, 2015 from http://www.ef.com/epi/.

Eichstaedt, J. C., Schwartz, H. A., Kern, M. L., Park, G., Labarthe, D. R., Merchant, R. M., Jha, S., Agrawal, M., Dziurzynski, L. A., Sap, M., Weeg, C., Larson, E. E., Ungar, L. H., and Seligman, M. E. 2015. Psychological language on twitter predicts county-level heart disease mortality. *Psychological science*. **26**(2):159-169.

Espenshade, T. J., and Fu, H.. 1997. An Analysis of English-Language Proficiency among U.S. Immigrants. *American Sociological Review*, **62**(2):288–305.

Fakayode, S. O., Mitchell, B. S., and Pollard, D. A. 2014. Determination of boiling point of petrochemicals by gas chromatography–mass spectrometry and multivariate regression analysis of structural activity relationship. *Talanta*. **126**:151-156.

Foong, K. P., and Goh, C. 1997. Chinese ESL Students' Learning Strategies: A Look at Frequency, Proficiency, and Gender. *Hong Kong Journal of Applied Linguistics*. **2**(1):39-53.

Fox, J. 1997. *Applied regression analysis, linear models, and related methods*. California: Sage Publications, Inc.

Freitas, M. A., & Costa, J. C. 2006. Shelf life determination using sensory evaluation scores: A general Weibull modeling approach. *Computers & Industrial Engineering.* **51**(4):652-670.

Garthright, W. E. 1991. Refinements in the prediction of microbial growth curves. *Food microbiology.* **8**(3):239-248

George, S. M., Métris, A., and Baranyi, J. 2015. Integrated Kinetic and Probabilistic Modeling of the Growth Potential of Bacterial Populations. *Applied and environmental microbiology.* **81**(9):3228-3234.

Ghavamnia, M., Kassaian, Z., and Dabaghi, A. 2011. The relationship between language learning strategies, language learning beliefs, motivation, and proficiency: A study of EFL learners in Iran. *Journal of Language Teaching and Research.* **2**(5):1156-1161.

Gibson, A. M., Bratchell, N., and Roberts, T. A. 1988. Predicting microbial growth: growth responses of salmonellae in a laboratory medium as affected by pH, sodium chloride and storage temperature. *International Journal of Food Microbiology.* **6**(2):155-178.

Gil, M. M., Brandao, T. R., and Silva, C. L. 2006. A modified Gompertz model to predict microbial inactivation under time-varying temperature conditions. *Journal of Food Engineering.* **76**(1):89-94.

Gompertz, B. 1825. On the nature of the function expressive of the law of human mortality, and on a new mode of determining the value of life contingencies. *Philosophical Transactions of the Royal Society of London.* **115**:513-583.

Granger, C. W., and Terasvirta, T. 1993. Modelling non-linear economic relationships. *OUP Catalogue.*

Green, J. M., and Oxford, R. 1995. A closer look at learning strategies, L2 proficiency, and gender. *TESOL quarterly.* **29**(2):261-297.

Griffiths, C., and Oxford, R. L. 2014. The twenty-first century landscape of language learning strategies: Introduction to this special issue. *System.* **43**:1-10.

Gujarati, D. N., and Porter, D. C. 1999. Essentials of econometrics 2nd ed. New York: Mcgraw-Hill.

Gupta, B. M., Kumar, S., Sangam, S., and Karisiddappa, C. R. 2002. Modeling the growth of world social science literature. *Scientometrics.* **53**(1):161-164.

Hardle, W. 1990. *Applied nonparametric regression* (Vol. 27). Cambridge: Cambridge University Press.

Hénon, M. 1976. A two-dimensional mapping with a strange attractor. *Communications in Mathematical Physics.* **50**(1):69-77.

Holland, J. K., Hadrich, J. C., Wolf, C. A., and Lombard, J. 2015. Economics of Measuring Costs Due to Mastitis-Related Milk Loss. In *2015 AAEA & WAEA Joint Annual Meeting, July 26-28, San Francisco, California* (No. 205638). Agricultural and Applied Economics Association & Western Agricultural Economics Association.

Holmes, P. 1979. A nonlinear oscillator with a strange attractor. *Philos. Trans. Roy. Soc. London.* **292**(2):419-448

Hofner, B., Hothorn, T., Kneib, T., and Schmid, M. 2012. A framework for unbiased model selection based on boosting. *Journal of Computational and Graphical Statistics.* **20**(4):956-971.

Hong-Nam, K., and Leavell, A. G. 2006. Language learning strategy use of ESL students in an intensive English learning context. *System.* **34**(3):399-415.

Hosenfeld, C. 1976. Learning about Learning: Discovering Our Students' Strategies*. *Foreign Language Annals.* **9**(2):117-130.

Hsiao, C. 2014. *Analysis of panel data* (Vol. 54). New York: Cambridge University Press.

Hurvich, C. M., and Tsai, C. L. 1989. Regression and time series model selection in small samples. *Biometrika.* **76**(2):297-307.

Hurvich, C. M., and Tsai, C. L. 1995. Model selection for extended quasi-likelihood models in small samples. *Biometrics.* **51**:1077-1084.

Ismail, R., Yussof, I., and Sieng, L. W. (2011). Employers' perceptions on graduates in Malaysian services sector. *International Business Management.* **5**(3):184-193.

Introduction to Mathematical Modelling. (n.d.). Retrieved 24 June, 2015 from http://www.maths.bris.ac.uk/~madjl/course_text.pdf.

Jacovides, C. P., Tymvios, F. S., Boland, J., and Tsitouri, M. 2015. Artificial Neural Network models for estimating daily solar global UV, PAR and broadband radiant fluxes in an eastern Mediterranean site. *Atmospheric Research.* **152**:138-145.

Johnson, R. A., Srinivasan, V., and Bolster, P. J. 1990. Sovereign debt ratings: a judgmental model based on the analytic hierarchy process. *Journal of International Business Studies First Quarter.* 95-117.

Karaboga, D., Gorkemli, B., Ozturk, C., and Karaboga, N. 2014. A comprehensive survey: artificial bee colony (ABC) algorithm and applications. *Artificial Intelligence Review.* **42**(1):21-57.

Katsanevakis, S. 2006. Modelling fish growth: model selection, multi-model inference and model selection uncertainty. *Fisheries Research,* **81**(2):229-235.

Kleinbaum, D. G., and Klein, M. 2010. *Analysis of Matched Data Using Logistic Regression.* New York:Springer.

Larsen, U., Pierobon, L., Wronski, J., and Haglind, F. 2014. Multiple regression models for the prediction of the maximum obtainable thermal efficiency of organic Rankine cycles. *Energy.* **65:**503-510.

Linton, R. H., Carter, W. H., Pierson, M. D., and Hackney, C. R. 1995. Use of a modified Gompertz equation to model nonlinear survival curves for Listeria monocytogenes Scott A. *Journal of Food Protection®.* **58**(9):946-954.

Locastro, V. 1994. Learning Strategies and Learning Environments. *TESOL Quarterly.* **28**(2):409-414.

Lozi, R. 1978. Un attracteur étrange (?) du type attracteur de Hénon. *Le Journal de Physique Colloques.* **39**(C5):C5-9.

Magogwe, J. M., and Oliver, R. 2007. The relationship between language learning strategies, proficiency, age and self-efficacy beliefs: A study of language learners in Botswana. *System.* **35**(3):338-352.

Malaysians most English proficient in Asia, ahead of Singaporeans, survery claims. (n.d.). Retrieved 24 June, 2015 from http://www.themalaymailonline.com/malaysia/article/malaysians-most-english-proficient-in-asia-ahead-of-singaporeans-survey-cla.

Massaro, D. W., and Anderson, N. H. 1971. Judgmental model of the Ebbinghaus illusion. *Journal of Experimental Psychology.* **89**(1):147.

McMeekin, T. A., Olley, J., and Ross, T. 1993. Predictive microbiology: theory and application. Chichester: Wiley.

McMullen, M. G. 2009. Using language learning strategies to improve the writing skills of Saudi EFL students: Will it really work?. *System.* **37**(3):418-433.

Minns, A. W., and Hall, M. J. 1996. Artificial neural networks as rainfall-runoff models. *Hydrological sciences journal.* **41**(3):399-417.

Mischel, H. N., and Mischel, W. 1987. The development of children's knowledge of self-control strategies. In *Motivation, Intention, and Volition.* Berlin, Heidelberg: Springer. 321-336.

Molina-Garcia, A., Guerrero-Pérez, J., Bueso, M. C., Kessler, M., and Gomez-Lazaro, E. 2015. A New Solar Module Modeling for PV Applications Based on a Symmetrized and Shifted Gompertz Model. *Energy Conversion, IEEE Transactions on.* **30**(1):51-59.

Montgomery, D. C., Peck, E. A., & Vining, G. G. 2012. *Introduction to linear regression analysis* (Vol. 821). New Jersey: John Wiley & Sons.

Murphy, E. M., and Nagnur, D. N. 1972. A Gompertz fit that fits: applications to Canadian fertility patterns. *Demography.* **9**(1):35-50.

Muñoz-Cuevas, M., Metris, A., and Baranyi, J. 2012. Predictive modelling of Salmonella:

From cell cycle measurements to e-models. *Food Research International.* **45**(2):852-862.

Naiman, N., Frohlich, M., Stern, H. H., and Todesco, A. 1978. The Good Language Learner. Research in Education series 7 Toronto: Modern Language Centre. *Ontario Institute for Studies in Education.*

Nisbet, D., Tindall, E., and Arroyo, A., 2005, Language learning strategies and language proficiency of Chinese university students. *Foreign Language Annals,* **38**:100-107.

Ngo, T. H. D., and La Puente, C. A. 2012. The Steps to Follow in a Multiple Regression Analysis. *SAS Global forum 2012.*

O'brien, R. M. 2007. A caution regarding rules of thumb for variance inflation factors. *Quality & Quantity.* **41**(5):673-690.

O'Malley, J. M., Chamot, A. U., Stewner-Manzanares, G., Kupper, L., and Russo, R. P. 1985. Learning strategies used by beginning and intermediate ESL students. *Language learning.* **35**(1):21-46.

O'Malley, J. M., and Chamot, A. U. 1990. *Learning strategies in second language acquisition.* New York: Cambridge University Press.

Oldewurtel, F., Jones, C. N., Parisio, A., and Morari, M. 2014. Stochastic model predictive control for building climate control. *Control Systems Technology, IEEE Transactions on.* **22**(3):1198-1205.

Osborne, J. W., and Waters, E. 2002. *Multiple Regression Assumptions. ERIC Digest.* Retrieved 11 April, 2014 from http://files.eric.ed.gov/fulltext/ED470205.pdf.

Oxford, R., 1990, *Language Learning Strategies: What Every Teacher Should Know.* New York: Newbury House.

Oxford, R. L., and Burry-Stock, J. 1993. Evolution, norming, factor analysis, and psychometric testing of the Strategy Inventory for Language Learning (SILL) throughout the world. In *annual meeting of National Council on Measurement in Education.*

Oxford, R. L., and Ehrman, M. E. 1995. Adults' language learning strategies in an intensive foreign language program in the United States. *System.* **23**(3):359-386.

Oxford, R. L. 1996. Employing a questionnaire to assess the use of language learning strategies. *Applied Language Learning.* **7**(1-2):25-45.

Pandian, A. 2002. English language teaching in Malaysia today. *Asia Pacific Journal of Education.* **22**(2):35-52.

Park, G. P., 1997, Language learning strategies and English proficiency in Korean university students. *Foreign Language Annals,* **30** (2):211-221.

Paul, K., Ripon Kumar Chakrabortty, M., and Salahuddin Ayuby, S. 2011. Selection of suppliers through different multi-criteria decision making techniques. *Global Journal of Management and Business Research.* **11**(4): 1-11.

Politzer, R. L., and McGroarty, M. 1985. An exploratory study of learning behaviors and their relationship to gains in linguistic and communicative competence. *Tesol Quarterly.* **19**(1):103-123.

Phillips, V. 1991. A Look at Learner Strategy Use and ESL Proficiency. *ReCAESOL Journal.* 57-67.

Proctor, C. P., Carlo, M., August, D., and Snow, C. 2005. Native Spanish-Speaking Children Reading in English: Toward a Model of Comprehension. *Journal of Educational Psychology.* **97**(2):246.

Puteh, A., and Sintok, U. U. M. 2012. Medium of instruction policy in Malaysia: the Fishman's model. *European Journal of Business and Social Sciences.* **1**(1):11-22.

Ramanathan, R. 2002. Introductory econometrics with applications. (5th edition). Ohio, South Western:Thomson learning Ohio.

Ritz, C., and Streibig, J. C. 2008. *Nonlinear regression with R.* New York:Springer Science & Business Media.

Rousseeuw, P. J., and Leroy, A. M. 2005. *Robust regression and outlier detection* (Vol. 589). Canada: John Wiley & Sons.

Rubin, J. 1976. What the good language learner can teach us. *TESOL quarterly.* **10**(1):77-98.

Ruppert, D., Wand, M. P., and Carroll, R. J. 2003. *Semiparametric regression* (No. 12). New york: Cambridge university press.

Salahshour, F., Sharifi, M., & Salahshour, N. 2013. The relationship between language learning strategy use, language proficiency level and learner gender. *Procedia-Social and Behavioral Sciences.* **70**:634-643.

Scarcella, R. C., and Oxford, R. L. 1992. *The tapestry of language learning: The individual in the communicative classroom.* Boston: Heinle & Heinle.

Scharf, L. L. 1991. *Statistical signal processing* (Vol. 98). Reading: Addison-Wesley.

Scholz, F. W. 2006. Maximum likelihood estimation. *Encyclopedia of Statistical Sciences.* **7**

Schwarz, G. 1978. Estimating the dimension of a model. *The annals of statistics.* **6**(2):461-464.

Seber, G. A., and Lee, A. J. 2012. *Linear regression analysis* (Vol. 936). Hoboken: John Wiley & Sons

Shaohua, X., Xiaoshuan, Z., Weijun, L., Dong, T., and Jinyou, H. 2014. Modeling growth of specific spoilage organisms in tilapia: Comparison Baranyi with chi-square automatic interaction detection (CHAID) model. *African Journal of Biotechnology.* **11**(26):6910-6917.

Shapiro, S. S., and Wilk, M. B. 1965. An analysis of variance test for normality (complete samples). *Biometrika.* **52**(3-4):591-611.

Singh, S., updated 18 April 2013. Muhyiddin: English a compulsory pass subject as early as 2016. Retrieved 24 June 2015 from http://www.thestar.com.my/News/Nation/2013/03/08/Muhyiddin-English-a-compulsory-pass-subject-as-early-as-2016/.

Stern, H. H. 1975. What Can We Learn from the Good Language Learner? *Canadian Modern language review.* **31**(4):304-318.

Taylor, H. M., and Karlin, S. 1998. *An introduction to stochastic modeling 3rd edition.* London: Academic press.

Teh, K. S. M., Embi, M. A., Yusoff, N. M. R. N., and Mahamod, Z. 2009. Language learning strategies and motivation among religious secondary school students. *The International Journal of Language Society and Culture.* **29**:71-79.

Verhulst, P. F. 1838. Notice sur la loi que la population suit dans son accroissement. Correspondance Mathématique et Physique Publiée par A. *Quetelet.* **10**:113-121.

Victori, M. 1993. Language Learning: Insights for Learners, Teachers, and Researchers. Andrew D. Cohen. *TESOL Quarterly.* **27**(1):119-120.

Wagenmakers, E. J., and Farrell, S. 2004. AIC model selection using Akaike weights. *Psychonomic bulletin & review.* **11**(1):192-196.

Wang, G. C., and Jain, C. L. 2003. *Regression analysis: modeling & forecasting.* New York: Graceway Publishing Company.

Weibull, W. 1951. Wide applicability. *Journal of applied mechanics*, **103**:293-297.

Weinstein, C. E., and Mayer, R. E. 1983. The teaching of learning strategies. In *Innovation Abstracts.* **5**(32):315-327.

Wenden, A. 1987. How to be a successful language learner: Insights and prescriptions from L2 learners. *Learner strategies in language learning.* London: Prentice Hall.

Wenden, A., and Rubin, J. (Eds.). (1987). *Learning strategies in language learning.* New Jersey: Prentice-Hall International.

Wenden, A. 1991. *Learner strategies for learner autonomy: Planning and implementing learner training for language learners.* New Jersey: Prentice-Hall.

Wharton, G. 2000. Language learning strategy use of bilingual foreign language learners in Singapore. *Language learning.* **50**(2):203-243.

Willmott, C. J., and Matsuura, K. 2005. Advantages of the mean absolute error (MAE) over the root mean square error (RMSE) in assessing average model performance.

Climate research. **30**(1):79-82.

Winsor, C. P. 1932. The Gompertz curve as a growth curve. *Proceedings of the National Academy of Sciences of the United States of America.* **18**(1):1-8.

Wong, M. S. L. 2005. Language learning strategies and language self-efficacy investigating the relationship in Malaysia. *RELC Journal.* **36**(3):245-269.

Wong, C. W., uploaded 23 June, 2015. The sad state of English in Malaysia. Retrieved 23 June, 2015 from http://news.asiaone.com/news/malaysia/sad-state-english-malaysia.

Wu, N., Huang, J., Schmalz, B., and Fohrer, N. 2014. Modeling daily chlorophyll a dynamics in a German lowland river using artificial neural networks and multiple linear regression approaches. *Limnology.* **15**(1):47-56.

Wunsch, G. 1966. Courbes de Gompertz et perspectives de fécondité. *Recherches Économiques de Louvain/Louvain Economic Review.* **6**:457-468.

Xiong, J., Zhang, G., Hu, J., and Wu, L. 2014. Bead geometry prediction for robotic GMAW-based rapid manufacturing through a neural network and a second-order regression analysis. *Journal of Intelligent Manufacturing.* **25**(1):157-163.

Yamano, T. 2009. Statistical ensemble theory of gompertz growth model. *Entropy.* **11**(4):807-819.

Zaaba, Z., Aning, I., Gunggut, H., Ramadan, F., and Umemoto, K. (2010). English as a Medium of Instruction in the Public Higher Education Institution: A Case Study of Language-in-Education Policy in Malaysia. *Selected Topics in Education and Education Technology*, Iwate: WSEAS press. 188-196.

Zainodin, H. J., and Khuneswari, G. 2008. Procedure in getting the best model using multiple regression analysis. *Journal of Borneo Science.* **23**:47-63.

Zakaria, H. A. 2000. Educational Development and Reformation in the Malaysian Education System: Challenges in the New Millennium. *Journal of Southeast Asian Education.* **1**(1):113-33.

Zwietering, M. H., Jongenburger, I., Rombouts, F. M., and Van't Riet, K. 1990. Modeling of the bacterial growth curve. *Applied and environmental microbiology*. **56**(6):1875-1881.