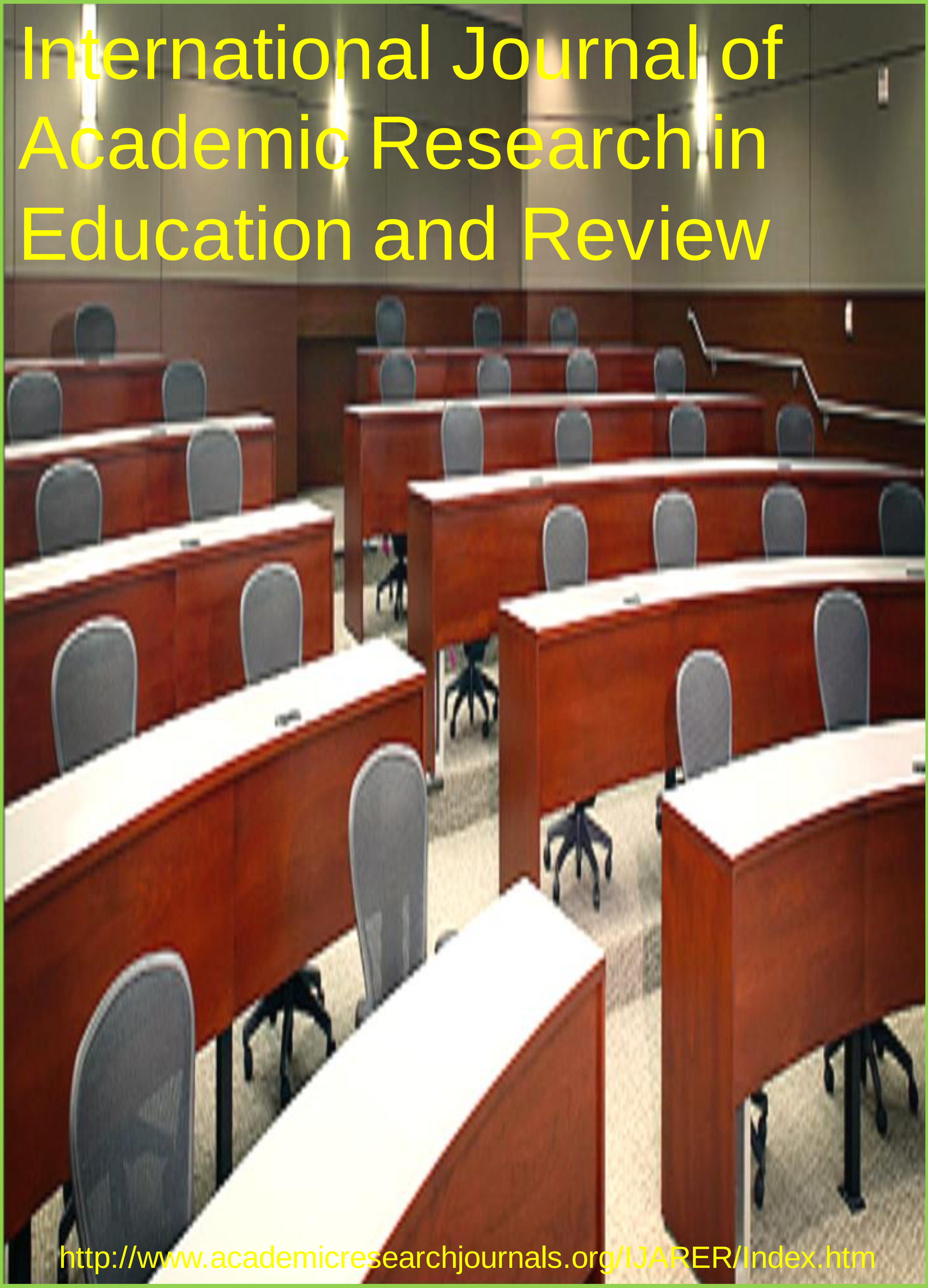
International Journal of Academic Research in Education and Review



http://www.academicresearchjournals.org/IJARER/Index.htm

ABOUT IJARER

The International Journal of Academic Research in Education and Review (IJARER) is published Monthly (one volume per year) by Academic Research Journals.

International Journal of Academic Research in Education and Review (IJARER) is an open access journal that publishes high-quality solicited and unsolicited articles, in English, in all areas of education including:

Gender
Education and child labour,
Adult Education
Agricultural Education
Art Education
Business Education
Distance Education
Economics of Education
Education and Child Labour
Education Policy and Leadership
Educational Psychology
Educational Technology
E-Learning
Elementary Education
Environmental Education
Health Education
Higher Education
Home Economics Education
Human Kinetics
Human Resource Development
Human Rights Education
Indigenous Education
Innovations and Change
International Education
Islamic Education
Language Education
Mathematics Education
Music Education
Non-Formal Education
Population Education
Pre-Primary Education
Reading Education
Religion Studies
Science Education

All articles published in IJARER will be peer-reviewed.

Contact Us

Editorial Office: ijarer@academicresearchjournals.org

Help Desk: support@academicresearchjournals.org

Website: http://www.academicresearchjournals.org/IJARER/Index.htm

Prospective authors should send their manuscript(s) to E-mail: ijarer@academicresearchjournals.org

International Journal of Academic Research in Education and Review

ARTICLES

Table of Content: February 2015; 3(2)

academicresearchJournals

Vol. 3(2), pp. 20-27, February 2015
DOI: 10.14662/IJARER2015.005

ISSN: 2360-7866
http://www.academicresearchjournals.org/IJARER/Index.htm

International Journal of Academic Research in Education and Review

Full Length Research

Learning as fuzzy structure: Integrating quantum nature of the learning processes measurements and teaching experience.

José Alejandro González Campos

Department of Mathematics and Statistics, Faculty of Natural and Exact Sciences, University of Playa Ancha.
E-mail: labesam.upla@gmail.com. Fono: 56-32-2500550

Accepted 17 February 2015

In this research, a methodological tool that can be used to make learning measurements over a numerical conception completely different is proposed. The new tool uses the concept of built-in measurements, which represent, in a closer way, the teaching and learning process nature. The process is called *built-of,* because the learning quantification involves the teacher's experience and his or her daily relationship with the student. In the integration of the quantum nature of measurements with the teacher's experience, we understand learning as fuzzy numerical structure due to the theoretical assumption about the imprecise nature of measurements from an abstract phenomenon. This conception and methodological proposal enhances modeling projections, analysis and understanding of the learning process.

Key words: measurement process, learning, fuzzy number

INTRODUCTION

The fuzzy set theory provides a mathematical treatment to some vague linguistic terms, such as ``about'', ``around'', ``close'', ``short'', among others. For example, from its point of view, numbers are idealizations of imprecise information expressed by means of numerical values. For example, when the height of an individual is measured, a numeric value is registered including some inaccuracies. Such inaccuracies may have been originated by the measurement instruments, human limitations, biased prior information among many others causes. If the ``real'' value of the height is represented by the number *h*, maybe it would be more correct to say that the value of the height is approximately and not exactly *h* (Barros, 2010). As proposed by Coppi et al. (2006), the fuzzy theory may provide an additional value to the statistical methods, due to the uncertainty inherent to the observable world and its associated information sources are combined beyond the traditional probability theory. For example, Tanaka (1982) introduced the concept of fuzzy regression, while Wunsche and Nather (2002) characterized the least squares method for fuzzy random variables. Moreover, Choi (2006) extended the fuzzy regression model for a censoring scheme. Dubois (2006) discussed some issues about possibility theory and statistical reasoning, and recently, Arabpour (2008) developed some theoretical elements regarding parameter estimation in fuzzy regression models. The connection between the estimation of parameters and the fuzzy theory has been studied by several authors. Cheng (1993) studied fuzzy systems using confidence intervals, and Chiang (2001) analyzed linear programming problems using confidence sets. Geyer (2005) established a relation between the concept of p-value and fuzzy structures, while Pachami (2006) introduced the concept of fuzzy confidence intervals.

To understand the learning process, several mechanisms or methodologies have been proposed, which seek to quantify learning (Author 2012), where it is set out that to measure learning it must be considered as a dynamic system constantly interacting with different realities. If in a concrete way there is already imprecision on measures, it is likely to be even more imprecise with this condition or typical element from abstract nature of man. For this reason, this work presents a new numerical structure, allowing to walk towards integral quantification of learning which is generated with interaction apparently without bonding: the experience that the teacher acquires in the classroom and the recent progress in mathematical-statistics models, specifically the proposal of numerical structures, it is transformed into a great step during the modeling process and understanding of the learning process phenomenon. These structures are known as fuzzy numbers.

LITERATURE REVIEW

In the understanding process of the learning phenomenon, it is possible to distinguish a varied range of proposals. For example, Cabrera et al (2010) proposed a mathematical-statistical methodology, in which the answering time to a stimulus is considered as a significant information element in order to know whether the learning structure is consistent or not. Fernández (1997) proposed the normal distributional model, as a representative, almost as a rule, from the learning process, however, this might be obsolete under the new projections of statistical modeling. Arellano-Valle (2005) reported that the data or the measures are those that have to give their model and also those in which the researcher does not have to force them to assume a determined behavior, leaving aside the symmetry assumptions and infinity supports. Authors (2012), based on Ojeda (2003),proposed to recognize the dynamic and interacting nature of a person and make it part of a model which considers to recognize these features, but on the basis of precise measures depending on the scores from a test. Nevertheless, Crombach (1951) indicated that a test is subject to reliability and validity which, evidently, strongly weakens the basis of measures precision, as an alternative to improve validity and reliability. García (2002) proposes a hermeneutic perspective, but it is just an improvement of those methods.

The perspective of learning as a fuzzy unit, has a lack of bibliographic references, and it is null in the specific educational area. However, this may have interesting applications in the learning tools or supervised learning (Soto 2011). Acampora (2010), who used the fuzzy view in the theory of system decisions, reported another potential use of this. Another interesting research regarding this growing methodology can be found in Barros (2010).

THE RESEARCH PROBLEM and OBJECTIVES

Recognizing the incapability of measuring learning precisely and the continuous seek of integral measurements methodologies, which allow to join co-variables and determining the significance of their effects, the problem of our research is: "to propose a methodology of a quantum representation of learning, which represents in an integral way a measurement based on the fuzzy numerical structures, which characterization is based on the teacher's pedagogical experience".

Objectives

- To describe the fuzzy structures.
- To incorporate the teaching experience on the characterization of a fuzzy number in the learning measurement process.
- To promote the interaction between objective quantum methodologies and subjective methodologies.
- To promote a line of research based on the conception of learning as a fuzzy structure.

RESEARCH METHODOLOGY

The methodology is propositional, aiming to beginning a new line of research about integral educational measurements and understanding the learning phenomenon.

Phases of Research

1. Preliminary analysis.
2. Quantification of learning based on the integration of the teacher's experience and numerical fuzzy structures.
3. Application.
4. A *posteriori* analysis and evaluation.

SOME PRELIMINARY ANALYSIS

The statistical modeling

Statistical models have been used in a wide range of situations. For example, to solve specific problems in engineering and different scientific areas, and constitute the basis of the theoretical formulation of inference and most of the statistical methods (Arellano-Valle, 2005: 93-94). Nowadays, statistical modeling has methodological and technological backups that give a great viability for an educational development in modeling. A statistical model is a platonic conception of theoretical that, in a very generic way, can be seen as a mental constructor that aims to study and better understand a phenomenon in which a cause and effect relationship underlies (Ojeda, 2003: 71-72). Understanding this section is essential to understand the meaning of this work, since one of the main objectives of education is to understand the phenomenon of learning, this phenomenon has an ideal model that perfectly explains this. However, in the process of proposing models, it should be increasingly considered characteristic elements corresponding to data we observe. In this sense, a proposal which can be used in the children quantification learning process, incorporating a suppose which represents nature's learning and its measurement.

Fuzzy Number

A fuzzy number is a numerical structure different from the generally used. This is specifically characterized by the incompletion of two typical characteristics of the Geog Cantor Set Theory, which are the contradiction law and the principle of the excluded third. Which set, if A is a set contained in a universal set U, thus $A \cap A^c \neq \phi$ and $A \cup A^c \neq U$, respectively. The unfulfillment of these two laws escape from our true or false logical system (Hailperin, 1986), because this perspective leads to degrees of veracity or falseness, that is we do not only have two characterization alternatives of a preposition, but also an infinite set of possibilities. To see these structures in depth see Arabpour and Tata (2008),

Formally, a fuzzy set is a collection of ordered pairs, say (x; F(x)) where the first component x represents a real number (x in IR) and the second component F(x) represents a defined function in x, which assumes values in the unitary interval [0,1] ($0 \leq F(x) \leq 1$). This function F(x) is called membership function and it is used to quantify the belonging degree or veracity of the observed *x* value. Note that in the Aristotelian logic there exist only two truth values, that is, a proposal is true or, in an exclusive way, it is false. In that case, the membership function would only generate two values: one or zero, and it is known as a characteristic function. Therefore, a fuzzy set is a generalization of the Cantor Set Theory and of the Aristotelian logic (Bradford 2011).

The fuzzy set theory is based on the logical of multiple values. For example, if the set *B ={1,2,3,4}* is a conventional set, each element has the same belonging degree to the B set, which means that *F (x) = 1*; for all $x \in B$. Now, the difference with a fuzzy set *A* is that not necessarily F (x) = 1, considering $x \in B$. Other examples and technical developments can be found in Barros, 2010.

As a particular situation for fuzzy sets, Hwang (2011) and Dubois (1980) define the concept of normal fuzzy set which they called fuzzy number. The characterization of this particularity proposes that if there exists a unique par of the form *(x , 1)*, that is if only a pair of values which constitutes the fuzzy set, has as a value in membership the real number 1, then that fuzzy set is a fuzzy number.

In our initial proposal, we will assume that the quantum observations of the measurement learning process, are fuzzy numbers, existing an x which satisfies F(x)=1. Which relates the traditional methodology of learning numerical quantification with our purpose.

In a functional way, a fuzzy number is represented by

$$A(x) = \begin{cases} L\left(\dfrac{m-x}{\alpha}\right) : x \leq m \\ R\left(\dfrac{x-m}{\beta}\right) : x \geq m \end{cases}$$

where *m* is called center value of the fuzzy number *A* and, α and β are called left and right propagation, respectively. From now on, we will represent a fuzzy number as $A = (\alpha, m, \beta)_{LR}$ where the subscript LR indicates that we must consider the form of the membership function to the left and the right of *m*. As a particular situation, if $\alpha = \beta$, then the fuzzy number $A = (\alpha, m, \beta)_{LR}$ will be called symmetric fuzzy number (Zimmermann, 1996).

5.3 Teaching experience and membership function

In fuzzy methodology, the researcher or expert experience has a meaningful contribution in the characterization of a membership function. So, under our context, the teachers, helped by their daily experience with the students, is who will value and select the function that best represents the student's learning. In Figure 1, some basic graphic forms of membership are presented, although nowadays it is been working on increasing this alternative number of modeling. In curve 1 of Figure 1, it

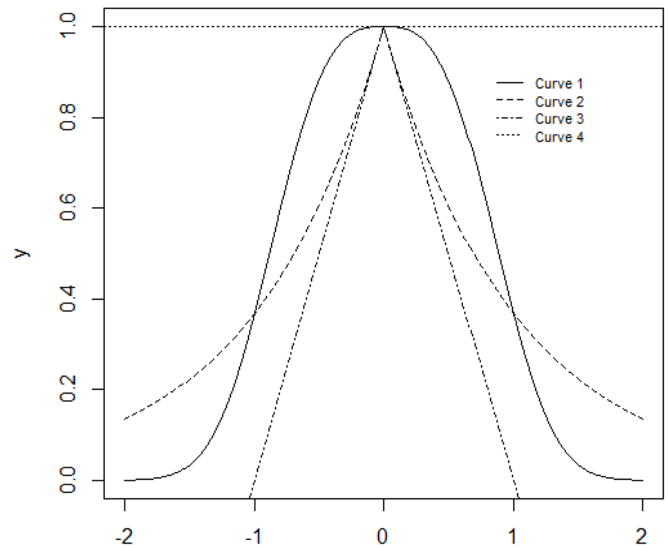
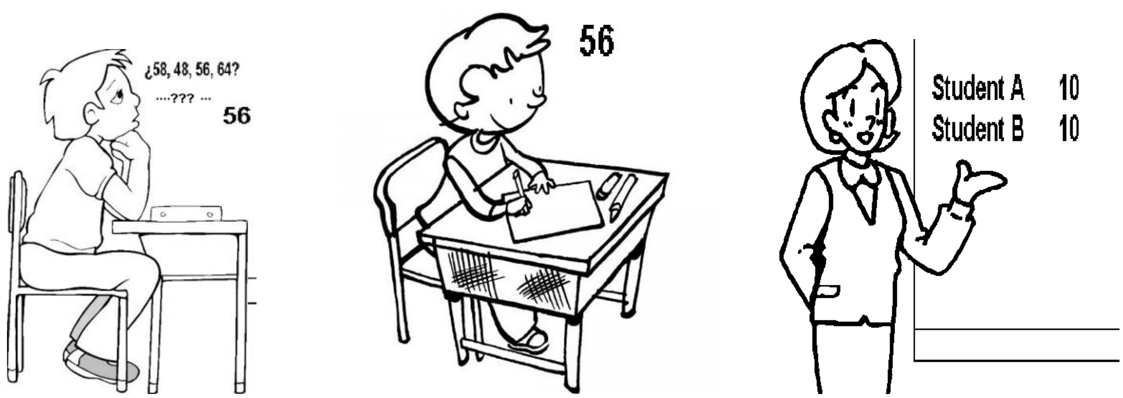


Figure 1. Different forms of the membership function.



Student A Student B Same Quantification

is observed that the decrease of the belonging degrees from neighboring elements to the observed value slowly decrease, which it does not happen in curve 2. Curve 3 it is considered as the simplest situation and it is generally used for its simplicity of calculus, on it the decrease of the belonging degrees is lineal. This membership function is known as triangular and in this particular case is symmetric triangular. Curve 4 has the intention of visualizing a conventional set, whit all the elements having the same veracity or belonging degree.

LEARNING QUANTIFICATION BASED ON INTEGRATION OF THE TEACHER'S EXPERIENCE AND NUMERICAL FUZZY STRUCTURES.

A subset of real numbers is generally used to quantify learning. The traditionally used learning quantification, is a process which tries to objectify the measure and make them comparable. However, it is worth considering, will this numerical label quantify learning in a precise way? The answer is no, because measurement or quantification processes are generally associated to tests whose reliability and validity are questionable. On the other hand, accuracy brings the concept of stability, that is, learning quantification would not vary among tests, however, it varies in a same content. Hence, it is necessary to propose methodologies which help to improve this process, which does not mean changing all this theoretical developments but to incorporate other relevant information in the measurement process. For example, Cabrera et al. (2010) stated that it is not sufficient to quantify whether an answer was correct or not, but there is also a temporary factor which is affecting the answer consistency, which is called by them as answering time for a stimulus. So, summarizing all the teaching and learning process is a quantum symbol, it is a mathematic-statistical methodology which in many times can be malign and overwhelming. All this, does not mean that real numbers are not a good methodology or a bad procedure, but it is still very far from the real representation of the complex system which is learning measurement. That is why we believe that evaluating mechanisms must open to new structures which combine traditional information of a real number and additional information which enrich the measurement.

When a student takes a test, and specifically a question, it is not only the correct answer the one that is in their cognitive structures, but there are many answers competing and it is the student who, as part of the learning and teaching process, must differ and chose one. As an example, In a simple experiment would be done with 100 students, where they are asked to "automatically answer how much is it 7 multiplied by 8", it is interesting to observe that a high percentage answer a different amount of 56, which it does not mean that they do not know but, they need more time to discriminate. That is, there are some other values that belong to these possibilities of answers but are a reflection and induction which inducts them to their answer. That is the way the students generates in their cognitive structures set of possible answers where each element of that set starts acquiring veracity degrees while they make the reasoning process. It is precisely in this process where an answer is selected as real, that is, the answer the students consider as correct.

In this context fuzzy structures have the property of modeling all this dynamic, where if it is contextualized we have, the membership function characterized in section 5.3, models the behavior of the veracity degrees from those possible answers generated by the student at the moment of the test, which will be technically identified as belonging group and all those answers which have as a belonging group 1 or equivalently 100% of veracity for the students, are the ones we observe.

From now on, the additional contribution in this measurement process will be done by the teacher, who is directly involved with this teaching and learning process, and is him the one selecting or proposing an explanatory model of the belonging groups. For example, let's suppose a student A presented difficulties when giving his or her answer, checking it many times, this means that it exited a set of possible answers which belonging degrees were high and they were competing to become the real student's answer. In that case, the membership function presented in Curve 1 from figure 1 would better represent this context. Now, let's suppose a student B, who is confident when selecting an answer, and also does not have doubts on its veracity degree, the membership function which best represents this process can be observed in curves 2 or 3, where it can be shown that the veracity degrees of other possible answers strongly decrease. This quantum integration process turns out to be quite informative and interesting, because the students A and B's situations, do not mention that the answer they gave has been correct but they do mention the structuring of the answer selection model. It is interesting to consider what it means a student on situation B when his or her answer has been incorrect, for it can be the reflection of a solid conceptual structure but mistaken. This means that the student understood the concept and its conceptual logic is consistent to him, but in a wrong way. For student A's case, giving a wrong answer can represent a maximum lack of understanding.

So, to go in depth regarding fuzzy structures, their numerical effectiveness and mathematical formalization, it is recommended to read Zadeh (1978).

APPLICATION

Our application is simple, but it will allow to show the effect and the difference between the learning quantification process with fuzzy numerical structures and the traditionally used method. We will consider 4 students A, B, C and D who took a test and we will specifically analyze their answers from one test question. The set question is: How many divisors number 12 has? The given answers are, respectively: 6, 5, 6 and 6.

From a quantum traditional perspective it can be said that:

- If the test was made up just for that question, students A, C and D would have the same learning quantification and evidently for student B, this will be minor.
- Learning achieved by students A, C and D is better than the one from student B.
- If the class was formed just for those 4 students, we will say it is a group relatively homogeneous.
- Three students succeeded the whole test and one did not.
- Teacher's methodology has a 75% of success.

The previous observations are based on the fact that the test must be a well formulated instrument and with all the desirable metric characteristics.

Under traditional methodology, factors like the emission of the answer process, enough timing for the given answer, consistence of the answer and clarity of the conceptual construct, among others; can be difficultly shown with the information given by the classical numerical quantification.

Note that, a consistent answer does not mean it is correct, but the conceptual construct the student created presents a consistent structure, however, it can be a

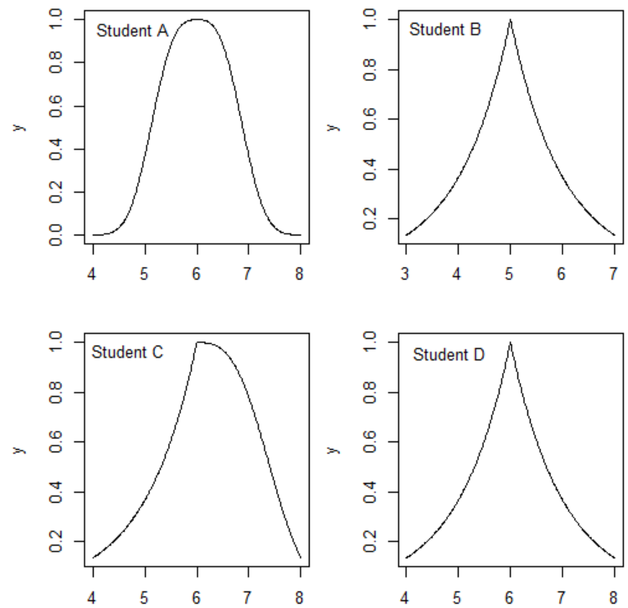


Figure 2. Forms of membership function to the quantifications of students A, B, C and D.

totally closed architecture. For example, when solving the problem, $x^2-1=0$, the student can have a conceptual structure depending on the procedure $x^2-1=0 \Leftrightarrow x^2=1 \Rightarrow x=\sqrt{1} \Rightarrow x=1$, which is understood as solid and consistent, however, its consistence it is supported on a wrong construct.

Now, from the fuzzy quantum perspective, the student's answers can be represented as in Figure 2. Under the fuzzy quantum integral analysis approach it can be stated that:

- The traditional quantum method is part of the proposed fuzzy methodology.
- **Student A**, gives a correct answer. Nevertheless, the discrimination process was complex for it is possible to visualize many wrong answers with strong veracity degrees. We could suspect that the time this process required helped with discrimination and selection of the correct answer. It is possible to conclude that this student can present concentration problems.
- **Student B** gives a wrong answer. However, the answer emission process shows strength and consistence, not existing other alternatives with high veracity levels, which allows us to conclude that the student's conceptual constructor is consistent but mistaken. We could say it was a random answer and it could be the reflection of unknowing the concept. An analysis from this perspective allows to naturally make the following assumptions: Maybe it is due to the fact that 1 it is not being considered as a general divisor or perhaps the concept of divisor the student embraced must be minor than the analyzed, among others.
- **Student C**, gives the answer in a correct way, although the emission process is quite interesting since the values which are minor than 6 definitely were not candidates or distractors with significant veracity levels. On the other hand, there are values higher than 6 as possible candidates which will allow us to assume, for example, that the student can have a confusion between the concepts of multiple and divisor, besides of the fact of suspecting that divisors can be numbers higher or equal to the number in question.
- **Student D,** gives a correct answer and shows consistence on the process, in a way that if we dismiss a random answer, this will reflect a clear, coherent and true conceptual construct.

Finally, let's think on the tracking and evolution of a **student B** during a semester in which its learning quantifications, mark 1, 2 and 3, are exactly the same to 8. According to a traditional analysis we would conclude that THERE IS NO EVOLUTION, whereas from the fuzzy integral representation perspective presented on Figure 3, we observe that there is an evolution, that there are changes, that the student's conceptual structures begin to

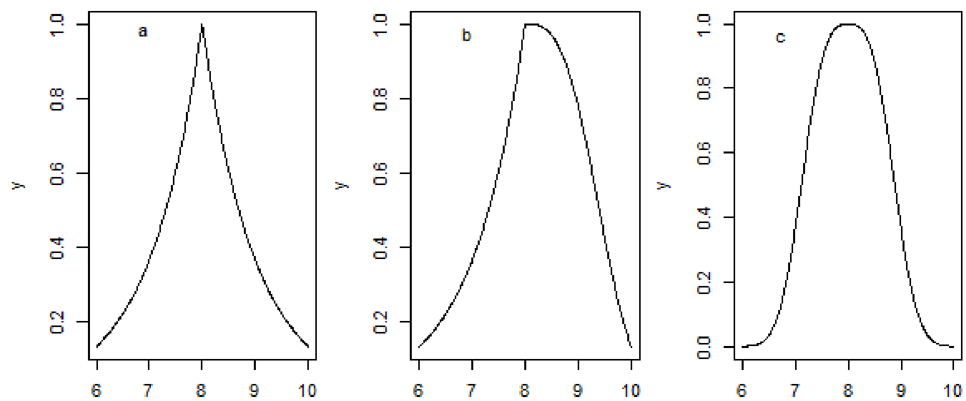


Figure 3. membership functions for notes in the first half of the student E.

weaken, that the student is not reflecting consistence on the answers and the projections according to this logic are unfavorable. Therefore, as teachers, we have the duty of reaction.

Finally, what is interesting from this proposal is its connectivity with the conventional analysis and the knowledge the teacher has over the student's learning, as it is presented on the application.

CONCLUSIONS

From the probabilities point of view, the fact of the evaluation actually made about learning coincides with what the student really known or learned is almost void, that is the probability that the number which we label learning equals real learning, is zero. So, assuming that learning is a fuzzy structure is a much more concrete proposal which allows conventional facts interact with experience and the teacher's daily contact, hence, the impact this methodological proposal has is undeniable.

This proposal promotes a change of mind, in which the conception of learning nature changes and it is located in a specific context to the nature of structures in which the imprecision of measurements is a fact, considering the relativity and uncertainty of a person.

The teaching experience, in this proposal, acquires real importance, for it is the teacher the one who evidences and experiments on a daily basis the relativism, changes and personal factors which involving a evaluative process.

All of those who are teachers and who are worried about the learning phenomenon generate a hierarchical structure of learning in the classroom, which few times differs from the quantifications we observe in a test and it is just that phenomenon the one we call experience, which we integrate in this proposal. We bear in mind that membership functions or possibility models we have to offer the teach are still limited, but we are still working on that lines.

REFERENCES

Acampora G, Fenza G, Muñoz E, Romera B (2010). Mejoras en el uso de aprendizaje con árboles fuzzy: un ejemplo de su aplicación en la toma de decisiones de un sistema coordinado. *ESTYLF, Huelva*. pp 643-648.

Arabpour A, Tata M (2008). Estimating the parameters of a fuzzy linear regression model, Iranian Journal of Fuzzy Systems, pp 1-19.

Arellano-Valle R, Genton M (2005). On fundamental skew distributions. *Journal of Multivariate Analysis* no.96, pp. 93-116.

Barros L, Bassanezi R (2010). *Tópicos de lógica fuzzy e biomatemática*. Segunda edición. UNICAMP-IMECC.

Cabrera E, González J, Montenegro E (2010). Test informatizados y el registro del tiempo de respuesta, una vía para la precisión en la determinación del nivel de logro de un saber matemático. *Estud. pedagóg*. vol.36, n.1, pp. 69-84.

Cheng C, Mon D (1993). Fuzzy system reliability analysis by interval of confidence, Fuzzy Sets and Systems, pp 29-35.

Chiang J (2001). Fuzzy linear programming based on statistical confidence interval and interval-valued fuzzy set, European Journal of Operational Research, pp 65-86.

Choi S, Kim K (2006). Censored fuzzy regression model, Journal of Korean Mathematical Society, pp 623-634.

Coppi R, Gil M, Kiers H (2006). The fuzzy approach to statistical analysis, Computational Statistics and Data

Analysis, pp 1-14.
Cronbach LJ (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16(3)*, pp 297–334.
Dubois D (2006). Possibility theory and statistical reasoning,Computational Statistics and Data Analysis, pp 47-69.
Fernández A (1997). Uso de la Distribución normal en la evaluación del aprendizaje. *Estud. pedagóg*., no.23, pp.51-63.
García S (2002). La Validez y la Confiabilidad en la Evaluación del Aprendizaje desde la Perspectiva Hermenéutica. *Rev. Ped*, vol.23, n.67, pp. 297-318.
Geyer C, Meeden G (2005). Fuzzy and randomized confidence intervals and p-values, Statistical Science, pp 358-366.
Ojeda M (2003). *La modelación estadística.* Universidad Veracruzana, Universidad Juárez Autónoma de Tabasco. México. pp 71-76.
Parchami A, Mashinchi M, Maleki H (2006). Fuzzy confidence interval for fuzzy process, Journal of intelligent and Fuzzy Systems, pp 287-295.
Soto C, Jimenez C (2011). Aprendizaje supervisado para la discriminación y clasificación difusa. *Dyna rev.fac.nac.minas.* vol.78, n.169, pp. 26-33.
Tanaka H, Uejima S, Asia K (1982). Linear regression analysis with Fuzzy model, *IEEE Trans. Systems Man*.12 (6) pp 903–907.
Wunsche A, Nather W (2002). Least-squares fuzzy regression with fuzzy random variables, Fuzzy Sets and Systems, pp 43-50.
Zadeh L (1978). Fuzzy sets as a basis for a theory of possibility. *Fuzzy Sets and Systems*, vol1, pp 3-28.

academicresearchJournals

Vol. 3(2), pp. 28-34, February 2015
DOI: 10.14662/IJARER2015.009

ISSN: 2360-7866
http://www.academicresearchjournals.org/IJARER/Index.htm

International Journal of Academic Research in Education and Review

Full Length Research

Management of University Curriculum in a Rapidly Changing Environment: Challenges and Prospects

Joseph Bosire

School of Education, Jaramogi Oginga Odinga University of Science and Technology. P.O Box 210-40601, BONDO – KENYA. E-Mail: jbosire@jooust.ac.ke

Accepted 27 February 2015

Political and socio-economic changes sweeping across societies together with globalization, scientific and technological processes are creating an increasingly competitive environment for universities in Africa. Therefore, the centralized system of curriculum development and management adopted by most universities in which university committees and senate have to approve curricula does not allow universities to adapt fast enough or even be the focal point of curriculum reforms. The rapidly changing environmental milieu of today and tomorrow necessitates that universities develop a mechanism and capacity for curriculum change at institutional level that will enable them to sustain their relevance and continue playing unique roles. This is a challenge that requires a system of leadership and governance that is sensitive to societal expectations and elastic to such changes so as to generate a sustainable mechanism of curriculum design and development that is equally responsive and relevant to the expectations of the individual, the society and the labour market

Key words: university, leadership, governance, curriculum, management, reforms

INTRODUCTION

Towards the last decade of the twentieth Century, many African countries were deliberately engaged in significant re-examination of their university education. Among the key points of focus were administrative structures, funding mechanisms, increasing student enrolments due to increased demand, and the relevance and quality of programmes and delivery. These concerns were prompted by global trends in technology, changes in the labour market patterns, the dynamic and ripple effects of free primary and in some countries, secondary education and the anticipated increase in the demand for university education in the near future. This paper discusses the issue of the process of developing academic programmes in the context of transformation and the responsiveness to addressing emerging socio economic interests of societies and countries.

The Context

The UNESCO sponsored 'African Ministers of Education Conference' that took place in Addis Ababa in 1961 marked an important beginning point of discussing about critical issues concerning education in Africa. This was at a time when most of the African countries were gaining self-governance. Then, the discussion topics largely focused on how African countries and young African governments could be supported and what they needed to do to achieve high enrolment rates, improve access and quality of delivery and make education relevant to the needs of its people and spur national development (UNESCO, 1998). The focus was on basic education, and to some extent, secondary school education and training. Today, the shift of attention is turning to university education with topics centered on relevance of curriculum and programmes, quality of programmes, delivery and staffing, management of students and financing, equity, access and quality of graduates (UNESCO, 1998; Chacha, 2006).

The increasingly competitive and rapidly changing university environment has prompted the heightened interest and attention on university education, especially the curriculum, or academic programmes offered. This environment is made up of but not limited to developments in the social, political, economic milieu, government structures, technology, labour and commodity markets, the university structure, culture and resources and the research market (Vossensteyn, 2007). Changes in these areas are likely to impact and subsequently result in changes in value systems, resources mix, diversity, students and programmes, knowledge, technology, stakeholders and the general economy.

These changes, largely brought about by among other factors, globalization and developments in science and technology, have consequences, which have serious implications to universities that do not adapt fast enough. Such consequences include losing recognition, loss of market and possible disappearance into oblivion. Yet, the clamor for industrialization and technological development has to be built on investing in a knowledge society, which fosters academic competitiveness, responsible and responsive research. African universities are expected to take on these challenges by recognizing globalization as a source of increasing competition and cooperation, and accept change through deliberate initiatives and efforts.

Change initiatives must begin from within to create systems of governance that can rapidly respond and adjust to societal expectations timely, the challenges of increasing costs, increasing student numbers against scarce resources and low research funding notwithstanding. This calls for strong universities that can change and initiate change so as to cope with the ever competitive global arena. At the center of the competition and cooperation are the programmes offered. Students, through peer pressure, the society and the market, are influenced to clamor for programmes regarded as competitive, which means training programmes for which jobs are readily available. This situation has a derivative effect on the process of curriculum design and development in universities. The fundamental principle is that the process of developing curricula in universities will require significant review for curriculum development in universities to be effectively responsive to the changing environment, the challenges of national development and societies' needs.

University Education and the Millennium Development Goals (MDGs)

The eight MDGs were determined as challenge areas on which governments strategized to address in order to ultimately enhance national and global economic growth and development. These challenges were prevalent in African countries, as much as they were prevalent in varying magnitudes in other countries of the world. The rallying thrust was on countries' abilities to marshal their strengths and opportunities, such as large youthful populations that supply abundant human resource and market, improved governance, a keen international community and donor partners and globalization to mitigate their challenges and achieve the MDGs. A fundamental strategy of achieving this is breaking with the notion of business as usual, by initiating deliberate policy interventions which can enhance wealth creation at the regional level. Education has always been regarded as the panacea to spurring economic growth and socio economic and political development of societies. Specifically, the education system and the curriculum are the major determinants of education outcomes and impacts. A deliberate policy on education and curricular reforms define the knowledge and competency based economy. Universities are given the mandate to foster this drive to produce the human capital requirements for the country to create wealth and sustain economic growth and development

Transformation of University Education

Universities must take on the challenge. In order to do this, deliberate and concerted efforts will be directed towards focusing on specific, significant and relevant high education curriculum, quality education and training for industrialization, innovative high education research agenda, and private and public sector partnership. This implies that the entire set up of university governance structures, funding systems and government/ministry support functions will need a critical re-evaluation. Given that universities are designed centres of excellence in specific and various fields, and in view of the difficulties of state funding, increasing irrelevance of some programmes, freezing of staff recruitment, and a disenchanted society, universities need to be allowed to be competitive to sustain their existence and survival. It also calls for each individual university institution and members of academic staff, to change not only in order to adapt, but also to contribute to the changes taking place (Weber, 2005).

On the basis of the necessity to initiate, embrace, adapt to and contribute to change, the following are important areas of reflection and adoption:

- The implications for the responsibility of public authorities for university curriculum
- The responsibilities of universities in curriculum design and management
- Governance and leadership in universities with respect to curriculum design and management
- The implications for faculties and faculty leadership
- Management of universities

The Responsibilities of Public Authorities for University Curriculum

University education is provided through public and private structures and arrangement. However, university education is a public responsibility. As a responsibility for public authorities, universities enjoy some autonomy and academic freedom. It follows then that university curriculum is also a public responsibility, and that the authorities entrusted with university curriculum have to be sensitive, or sensitized to this fact so that they are responsible to the public for the production of a curriculum that responds to societies' expectations. Given that universities enjoy autonomy and freedom, they can take this to advantage to design curricula that is relevant and effective in terms of student outcomes.

This observation is advocated on the basis that university education produces high private and collective returns on investment, and because of efficiency and equity reasons, it is a public good since the market may not be efficient in allocating benefits, and is not capable of accounting for the social benefits of university education to the whole community (Weber, 2005). The responsibility for public authorities is as stipulated in relevant government documents and in the university Acts and Government Charters/statutes of various public and private universities respectively (For example, Republic of Kenya, 1999). Accordingly, public authorities have the following responsibilities:

- Exclusive responsibility for the framework within which university curriculum is designed and managed,
- A leading responsibility for ensuring that all citizens have equal opportunities for accessing relevant and quality university education and training.
- Mutual responsibility for ensuring that the education and training provided meets the expectations of the labour market and other sectors of society.
- Substantial responsibility for the funding and the provision of opportunities for partnerships, stimulating intellectual life, economic and cultural development of the society.

In addition, universities are expected to operate as autonomous institutions. This is an instrument university authorities can utilize to exercise their responsibilities exclusively and mutually to motivate and stimulate the development of university education – to help in generating scholarship, academic buoyancy and new knowledge as a long term objective of universities to society. It has been shown that highly controlled universities, especially in communist inclined states (especially in Russia and China) are characterized by intellectual and social stagnation, and low rankings (Weber, 2005). Autonomous universities have been known to be superior, since they are proactive and entrepreneurial in approach. Autonomy has the ability to break the vicious circle associated with state control and regulation – such as killing initiative, which would lead to more 'bad' regulation. The scope of real autonomy would cover vital components of the organizational structure that are likely to affect the process of curriculum design and management. These include, but may not be limited to:

- Internal organization, the decision making processes and the selection of leaders
- The study programmes, structure of degrees, and qualification framework (to what extent should this be decided and regulated by the state?)
- Choice of staff, academic and non-academic – a faculty matter?
- Funding mechanisms and expenditure, especially with respect to fees
- Choice of students with respect to national objectives on equity in access and opportunity

The matter of university autonomy and freedom cannot be exhaustively discussed here, but important is that the state as a public guarantor has responsibility of ensuring that universities remain committed to national goals of education and development, hence maintain relevance in their curriculum and research agenda (Fall, 1998; Weber, 2005).

The Responsibilities of Universities in Curriculum Design and Management

Irrelevance of programmes, inadequate funding, increasing public pressure and increasing competition are pushing universities to a state of oblivion. Specifically, public universities are at cross roads – with most of their programmes declared unpopular and the few popular ones having very low absorptive capacities and expensive to operate. Similarly, against the issue of relevance, universities are expected to have programmes, or curricula that have impact on both the world of work and the world of no work, the process of industrialization and sustainable human resource development (Mungai, 1998). The challenge therefore lies in refocusing the purpose and function of university education as a basis for initiating viable and feasible curriculum reforms which will make the university a powerful instrument of preservation, transmission and transformation, and jettison its elitist approach to national and social issues. This means that reforms in curriculum are expected to be deliberate towards serving the needs of national development without necessarily compromising the universality of university education.

This notwithstanding, it is realizable that universities today are inevitably pushed into a conflict of roles and responsibilities of assuring on quality of services and programmes against reduced state support. At the same time, universities are expected to be *responsive* and *responsible* to the short term and long term needs of the society. This is viewed against the background of the university as perhaps the only institution that has maintained its role in history, as one able to secure and transmit valued cultural heritage of society, create new knowledge and possessing the right status to analyze society's problems independently, scientifically and critically.

However, the two qualities have to be balanced carefully. Being responsive means that universities should be societies' watch dogs – receptive of what society expects. Oftentimes, responsiveness may be a short term stimuli that may be politically instigated to satisfy an immediate need that is likely to be partisan. Such case may be self defeating if adopted. Universities should be responsible as institutions that should be able to guide in reflection, public responsibility and policy making in society (Weber, 2005). Universities have the strength and freedom to pursue their search for knowledge away from the short term and undue pressure but at the same time, to remain relevant in the curriculum they offer by being responsive and acting responsibly to the societies they serve. This balance is even more significant in continually changing environments, hence the necessity to articulate the requirements of responsiveness and responsibility.

Governance and Leadership in Universities with Respect to Curriculum Management

The Traditional System of Governance and Change Process

The greatest challenge to universities is to become strong institutions, maintain substantial autonomy and still be accountable to the public authorities on which they depend and all other stakeholders who constitute their clients. Seen in this perspective, it is even a greater challenge for universities to adapt to the rapidly changing environment, or even initiate the change. This will largely depend on the system of governance structures and the decision making process adopted by universities (Vossensteyn, 2007). One observation made out of experience and common debates on university decision making process is that universities are not changing fast enough to accommodate the rapidly changing environment. This is likely to limit the capacity of the university faculty to constantly renew their knowledge and to innovate, and subsequently inhibit the curriculum design process and the deliverance of society's needs.

The existing governance structures and the decision making processes of university leadership with respect to curriculum making are obscure, unnecessarily overlapping, questionable capacities of some of the decision making bodies and hence inability to produce clear and significant decisions. This is particularly significant when viewed against the constitution of some of the more important decision making bodies on curricula – the boards of undergraduate and post graduate studies, the deans' committees and the senate. Recently, one of the structural changes on governance in some African public universities was the restructuring of academic departments through creation of mergers for purposes of reducing administrative costs. The consequence of this initiative has been the compromising of professionalism and specialization in the growth of scholarship to an extent that even, perhaps the quality and quantity of research output may have deteriorated (Chacha, 2006)

The decision making process on university curriculum is often lengthy, cumbersome and disillusioning. The different layers of academic leadership and the committees or boards that are not carefully constituted together with the centralized tendencies in curriculum planning make it difficult for universities to be responsive quick enough to the changing environment. This is the style of bureaucracy, or bureau-professionalism (Vossensteyn, 2007), which challenges and inhibits the universities' abilities to be effectively responsive to their own traditional roles and the dynamic nature of the societies they are expected to serve (Chacha, 2006).

Developing a System of Governance Focusing on Change

A useful transition that would enhance curriculum planning to accommodate tangible and workable reforms would be a move towards having more flexible, fast moving performance oriented forms of modern organization – managerialism or the new public management as opposed to administration. The former denotes changes in the structure and processes of organizations that emphasize on results rather than the process, while the latter focuses on the processes rather than the results. In spite of its contradictions, managerialism is expected to strengthen the organizations' abilities to respond to the changing environment because of some of its in built advantages, such as multi faceted approach to issues (i.e. top down and bottom up), management freedom, empowered customers, flexibility and innovation, emphasis on better performance, reduced bureaucracy, staff motivation, emphasis on managerial accountability and reduction of internal scrutiny, improvement on programme coordination, and increased quality of service and product.

In addition to overcoming the complex decision making process, the faculty lecturers and professors, are known to be fairly rigid to change, conservative and often slow down the change process rather than accentuate it. They prefer the status quo, especially given the uncertainty of the likely benefits of any change. In institutions where the decision making process is heavily decentralized, and where the majority of the bottom hierarchy is composed of old faculty, then a new thinking might hardly emerge on the existing curriculum. However, borrowing from the economic theory of federalism, and using the principle of subsidiarity, decisions on curriculum changes should be initiated by faculty members as the lowest category in the decision making ladder. This is because, irrespective of the effect of the decision, there will likely be existence of externalities, potential economies of scale and the need for equals to be treated equally. This way, the professors and lecturers will enhance their creativity and improve on institutional loyalty.

The Implications for Faculties and Faculty Leadership

The organizational structure of most universities places deans of faculties as middle level managers in the hierarchy of university management. However, though they hold an important portfolio of being directly in charge of academic programmes in the university, they occupy the lower echelons of the decision making process. Faculties constitute stakeholders who contribute invariably to curriculum building and the general environment of the university which includes students, academic staff and deans.

Students as the major consumers of curricula should assist in defining their expectations and participate in giving feedback for improving the quality and relevance of the programmes they go through. University academic staff are the key human assets in curriculum development (Orth, 2007). They need to be facilitated with an environment that would spur their creativity, freedom in defining and reviewing their areas of specialization, creation of new programmes, and commitment to students, and participation in research.

Deans of faculties hold an important position between the senior university management and the academic departments. Though they hold a subsidiary position, they control all aspects of curriculum design, management, implementation and evaluation. They are also expected to initiate reforms and channel reforms emanating from the university management to the faculty members. However, in a traditional set up, deans are elected and represent their members. They therefore often and usually likely take a protective stance whenever issues arise and therefore may not be effectively proactive in advancing and supporting organizational changes. They may be the most conservative agents in the university's administrative hierarchy.

Management of Universities for Reforms

Schematically, universities are managed through a process of decision making ranging from council through senate, faculty boards, the department and the student leadership or congress. Each of these levels contributes to the process of curriculum design. Though the structure appears decentralized and all inclusive, it does present aspects of rigidity that can inhibit the responsiveness of curriculum design to emerging societal changes. In order to respond to the challenge, universities need to embrace a governance structure capable of adjusting to the requirements of the moment and the authority to implement decisions without compromising administrative controls. This implies that the prospects of universities in designing academic programmes that are responsive to the rapidly changing socio economic and political environment will depend on the implementation of strategic decisions focusing on governance (Orth, 2007). These may include the quality of staff and staffing norms, faculty structures, establishment and revitalization of internal and external quality assurance and monitoring mechanisms and restructuring of senate and associated administrative boards.

1. The day-today affairs and the strategic decisions of the university are made and guided by the vice chancellor/rector/president and an executive team of administrators. The decisions cover setting up broad priorities, such as the creation of departments, determination of the administrative structure of departments and the overall institution, and partnerships with other institutions. These decisions affect the curriculum offered. The competency associated with the decision making process plus the power to apply and implement the decisions are vital attributes in determining the curriculum innovations and the quality of the curriculum offered. The challenge has been on the pecuniary and non pecuniary incentives that accompany the decisions as a reward system to faculty members to facilitate effective and quality curriculum designs that can spur institutional relevance rather than the blunt use of rules and power (Weber, 2005).

2. The senate as an assembly of academic staff is the most vital organ that determines university curriculum. Usually, especially in most universities in East Africa, the senate is the final body that vets academic programmes from departments and faculties. However, because of the manner in which senate is constituted; it has been established to be the most rigid obstacle to innovative ideas to modern curriculum designs. The problem is accentuated with the merger of departments, in which case the senate may completely luck the expertise and therefore the competencies necessary to vet certain specialized academic programmes. Oftentimes, due to strategic lobbying, or negative competitions by senators, poor programmes may sail through, or good programmes may be jettisoned respectively. In order to improve this situation, it is commendable to have an administrative board that comprises of all stakeholders to make strategic comments on university academic programmes through consensus and shared governance. This will have the advantage of having a group of individuals, who are competent, have shared interests in the future of the institution, rather than defending their positions or those of their friends.

3. The organizational structure of the university and the decision making process can affect curriculum making and management, and the extent to which it can remain relevant to societal expectations. There are three main administrative models in universities; the traditional model with faculties and departments; a flatter type of model with only one level of subdivision, such as schools, departments or colleges; and the matrix system (Weber, 2007). The latter is organized according to the two main visions of the university – teaching and research.

The importance of the universities' organizational structure is in the extent to which it facilitates effective and efficient decision making; the availability of the required critical mass of professors in various departments; the extent to which departments embrace interdisciplinarity (Note that universities in Europe are reengineering themselves to promote interdisciplinarity, have a critical mass and the capacity for change). This is because the breaking of traditional disciplines into micro disciplines and micro-specializations necessitates interdisciplinarity since societal problems require joint input of many disciplines (Orth, 2007).

4. Development of good governance as a tool for effective curriculum management. The responsiveness of the curriculum and responsibility of the university today requires a governance structure that supports strategic decisions required by the fast changing environment and secure the support of the academic community for implementation. In this respect, *governance will be defined as the set of bodies and functions, their respective competencies and the procedures by which they interact to make decisions at the level of and within the institution (Weber, 2007:8).* Management, on the other hand, *is the use of suitable tools to prepare and implement decisions and policies as well as to monitor their efficiency and effectiveness (*Weber, 2007: 15). A university that wishes to develop academic programmes as a priority management function must develop a strategic plan, a financial plan, maintain a culture of quality and generating periodic evaluation reports, make informed decisions based on core sets of indicators/data, and embrace a spirit of continuous communication and dialogue.

CONCLUSIONS AND RECOMMENDATIONS

The key purpose of this paper was to highlight the significance of university governance and leadership in relation to curriculum management within the context of a fast changing socio-economic and political environment. The thrust of the argument is based on the importance attached to building a knowledge modernist oriented economies. Fundamentally, it is the concept of knowledge society and the associated cognitive abilities and social skills, innovativeness, initiating and adapting to change that are contributing to economic growth through value addition. This constitutes the basis upon which there is growing interest on reforms in high education curriculum as it is in these institutions that:

1. Millions of students are trained who will drive the economies of the world
2. Responsibility for ultimate growth of the economy is determined
3. High quality research which offer solutions to societal problems is conducted
4. International networks and collaborations are maintained

It should be noteworthy, therefore, that the governance structures of public universities will be the driving factor in determining and influencing the dynamism and responsiveness of curriculum to the kinetic nature of societies they serve. This ideal may be realized through deliberate and strategic restructuring of governance structures; improving on management responsibility in developing an enabling working environment and initiating mechanisms for staff motivation. Further, espousing individual and institutional collaborations and networking; integrating ICT into faculty development plans; invigorating and diversifying funding sources and developing mechanisms for labour and society sensors as a basis for curriculum reforms. These are by no means not easy to achieve without a deliberate, conscientious, well integrated and coordinated mechanism involving the various governance structures relevant to and involved with curriculum design, implementation and job placement.

REFERENCES

Chacha, N. Chacha. (2006). “Role of Governance Structures in Enhancement of Quality Assurance in Higher Education”, In Katana, G., M. Fremerey, and S. Amini (eds), *Network for Quality Higher Education*. Nairobi: Regional Eastern Africa Unistaff Alumni Network, pp 13 – 16.

Fall, P. Nalla. (1998) “Relevance of High Education in Africa: The Point of View of The World Bank”, In UNESCO (Ed), *Higher Education in Africa: Achievements, Challenges and Prospects*, Dakar: UNESCO, pp 153 – 162.

Rayapeni, L. C.A. (1990) “Educating Africa, Challenges and Promise”, In Kaba, D.B.and L.C.A. Rayapeni (Eds), *Relevant Education for Africa,* Yaoundé: Professors World Peace Academy, pp 1 – 19.

Republic of Kenya (1999) Totally Integrated Quality Education and Training. *A Report of The Commission of Inquiry Into The Education System of Kenya*. Nairobi: Government Printer.

Mungai, J.M. (1998) “*Relevance of High Education with a Special Reference to East Africa*”, In UNESCO(Ed), Higher Education in Africa: Achievements, Challenges and Prospects, Dakar: UNESCO, pp 130 – 145.

Ndoye, M. (2000) “Towards an African Renaissance and Renewed Partnerships: Lessons From a Biennial Meeting”, - Association *for the Development of Education in Africa Newsletter*, Vol. 12, No. 2, pp: 9 – 16

Orth, M. (2007) “The Feeling That You Can Achieve Something”’ *Deutschland. Forum For Politics, Culture and Business*, Vol. 16, No. 4 (August/September), pg. 47 – 49

UNESCO (1998). *Higher Education in Africa: Achievements, Challenges and Prospects*. Dakar: UNESCO.

Vossensteyn, H. (2007) “Changing Nature of University Governance in the Wider Perspective of Public Sector Reform.”. Paper Presented at the 1st International Deans’ Workshop, University of Applied Sciences, Osnabruck, Germany, 6th to 16th May.

Weber, L.E. (2005) “Nature and Scope of the Public Responsibility for Higher Education and Research”. In Weber, L.E. and S. Bergan, (Eds). *The Public Responsibility for Higher Education and Research*, Strasbourg: Council for Europe High Education Series No. 2. pp 13 – 28.

academicresearchJournals

Vol. 3(2), pp. 35-44, February 2015
DOI: 10.14662/IJARER2015.006

ISSN: 2360-7866
http://www.academicresearchjournals.org/IJARER/Index.htm

International Journal of Academic Research in Education and Review

Full Length Research

Predicting Post-Baccalaureate Student's GPA from cumulative Undergraduate GPA using Logistic Regression Analysis: *A Test of Hypothesis*

Oscar Wambuguh, M.Sc., Ph.D.

Associate Professor, Health Sciences, Department of Nursing & Health Sciences, California State University, East Bay
Telephone: (510) 885-3252; E-mail: oscar.wambuguh@csueastbay.edu

Accepted 16 February 2015

Post-baccalaureate (postbac) students are non-traditional students returning to school after completing their bachelor's degrees in either science or non-science majors. As a result, they are deemed to be more conscientious individuals who are not only better self-disciplined and high in self-achievement, but also more hardworking, highly motivated, well organized and ambitious in nature. Using a sample of 372 students accepted into our postbac program from fall 2011 to winter 2014, data regarding their graduating institution and its geographical location, and students' academic achievement as measured by cumulative grade point average, was analyzed. Results indicate that: 1) most postbac students applying to our program come from California and a small percentage from international locations. 2) Students' cumulative undergraduate GPAs weakly correlate with their postbac cumulative GPAs; but they significantly differ from postbac cumulative GPAs after at least one full year of coursework in our program. 3) Logistic regression analysis showed that students entering the postbac program with overall undergraduate GPAs close to 3.0perform better than those with lower undergraduate GPAs. 4) Logistic regression analysis also showed that students entering the program with at least a 3.0 GPA had a higher probability of attaining a cumulative postbac GPA of at least 3.7, than those with lower than a 3.0 GPA. Postbac students bring a multiplicity of important personal traits like the ability to overcome adversity, tenacity, work and varied life experiences, and a relatively high level of maturity and responsibility compared to undergraduate student pools. Factors other than academic aptitude are becoming a critical part of the admissions process for many advanced programs worldwide. Many studies focusing on student achievement and admissions applaud and reiterate the importance of such a broad-based and holistic approach to student admissions particularly in graduate and health professional programs.

Keywords*:* undergraduate, post-baccalaureate, postbac, academic performance, biomedical school, GPA, logistic regression.

INTRODUCTION

Student academic performance has been the subject of intense research in higher education institutions for the last two decades. Academic achievement has generally been described as behavior resulting into two academic outcomes: success or failure. Academic failure is a central issue in higher education worldwide wasting time and financial resources in addition to straining the students' mental, family and social environments (Jannati et al., 2012). Amongst educators and biomedical school admissions offices, there is an almost universally accepted notion that among other factors, students who perform well in foundation (lower division) and advanced (upper division) science courses; and score above the national average in the required entrance tests (for example, the Medical College Admission Test or the Dental Admission Test in the United States) have increased chances of getting accepted for graduate biomedical training. Post-baccalaureate students are often more mature and more experienced, and deemed to possess better organization skills, are better motivated, seek assistance when needed, utilize available resources optimally, and are able to adapt their study habits to suit their academic needs (Zimmerman, 1998; Dooden, 2008; Wambuguh & Yonn-Brown, 2013).

A review of the literature on human learning indicates that learning is a complex human activity that cannot easily be mapped by any one universal model. Academic success is usually associated with personality factors (that might include age, cognitive abilities, and student learning styles) and contextual factors (like family and social environment, course assessment procedures, and learning activities). While some authors cite intelligence as one of the major determinants of academic success (for example, Ackerman & Heggestad, 1997; Sternberg & Kaufman, 1998; and Akomolafe, 2013); others have explored the relationship between personality variables (like neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) and academic success (for instance, Farsides & Woodfield, 2003; Chamorro-Premuzic & Furnham, 2005; O'Connor & Paunonen, 2007; Conrad & Party, 2012). Citing previous studies (particularly those of Chamorro-Premuzic & Furnham, 2008 and Conrad & Patry, 2012), Akomolafe's research (2013) further finds that one personality variable (conscientiousness) as the single most important predictor of academic success. According to Akamolafe, conscientious individuals are not only better self-disciplined and high in self-achievement, but are also known to be more hardworking, well organized and ambitious in nature (2013). Other studies have focused on academic and social integration particularly for non-resident students (Rienties et al., 2012); supportive counselling programs (Jannati et al., 2012); and family support (Cheng et al., 2012). Additional studies suggest other factors to be important including student work involvement both inside and outside campus (Alfano & Eduljee, 2013); quality of students, teachers and the institution (Ahmed et al., 2012); student motivational levels (Goodman et al., 2011); student academic ability, effort and persistence (Meltzer et al., 2001; Fraser & Killen, 2005); lecture attendance (Thatcher, 2007); and the role of socio-psychological factors (Malefo, 2000). The role of student acquisition of specific skill sets that emphasize self-assessment, monitoring, adjustment, self-control, and motivation; the courage and ability to adopt efficient learning strategies; and resiliency in case of academic difficulties has previously been described in Wambuguh and Yonn-Brown's study (2013).

Building on this body of research, the current study focuses on academic performance of students who have completed their undergraduate degrees but: a) are lacking the required foundations science courses required by biomedical school doctoral programs (primarily medicine, dentistry, pharmacy, optometry, and veterinary medicine); b) have competed the foundation sciences coursework but have a low Grade Point Average (GPA) which makes them uncompetitive in the biomedical school application process. Such students are accepted into a variety of post-baccalaureate programs like the one at our university which helps them complete the required foundation science coursework; and/or provide a set of enhancement upper division course work which improves their competitiveness for biomedical school programs application. Using logistic regression, the study uses student cumulative undergraduate GPA to predict academic performance at the post-baccalaureate level.

Study Hypothesis and Objectives

We used academic data from our formal post-baccalaureate (hereafter referred to as postbac) students accepted at our campus after completing their undergraduate education. Our postbac program accepts two categories of students: those who have earned a bachelor's degree in a science field (ADV); and also those who have earned it in a non-science field (career changers or CCs). We hypothesized that a student's cumulative undergraduate GPA of at least 2.80 increases the likelihood of the same student attaining a high postbac GPA of 3.7 and above, to more than 50% after one continuous year of coursework. Our specific objectives were to:

i) map out the "source" of our students by geographical location: in-state, out-of-state or International.
ii) find out whether there was a correlation between students' undergraduate and postbac cumulative GPAs.
iii) determine how cumulative GPAs varied in:

a) for both undergraduate CC and ADV students.
b) for both CC and ADV postbac students.

Table 1. Numbers of students applying from US states and from countries outside the US

State	Number of Applicants
California	1197
New York	22
Texas	9
Maryland	9
Illinois	9
Arizona	7
New Jersey	7
Massachusetts	6
Michigan	6
Vermont	6
Pennsylvanian	5
Washington	5
Other States (<5 applicants each)	41
International Applicants	22
Total	**1351**

c) and how cumulative undergraduate GPA predicted the probability of attaining a cumulative postbac GPA of 3.7 and above.

METHOD

Data for the geographical location of each postbac student accepted was obtained from our university's admissions records. We used academic data from our formal postbac students from the past four years (fall 2011 to fall 2014). Both geographical and academic data were amalgamated from the individual cohorts to increase the total sample size to 372 students. Academic data for each student was recorded in two columns in a *Microsoft Excel* spreadsheet: student cumulative undergraduate GPA and postbac cumulative GPA.

Statistical analysis

Data from undergraduate and postbac levels was tested using Spearman's Rank correlation coefficient to assess the nature and strength of the relationship between the two sets. The Student's t-test was next used to determine the difference between mean GPAs at both undergraduate and postbac levels for NSDs alone, ADVs alone and for all students. Lastly, a logistic regression model was used to test how well: a) earning a graduating GPA of between 2.80-2.99 predicted student postbac academic performance (measured by an overall postbac GPA of 3.7 and above); and b) earning a graduating GPA of 3.0 and above predicted student postbac academic performance (measured by an overall postbac GPA of 3.7 and above).

RESULTS AND DISCUSSION

Postbac students applying to our program come from all parts of the world, but most primarily come from universities in the United States (98.4%) with a small, but significant international student population (1.6%). Not unexpected, the state of California, home to our university, accounts for the lion's share with 88.6% of the total number of applicants (Table 1). Partly due to the short duration of the program (average:1-2 years), travel distance, out-of-state tuition considerations, recommendations from peers in person and through social media, plus the level of support provided and quality of our program, many students often choose schools in their home state before applying to other postbac programs in the country. Our small pool of international students usually comes from Canada, China, Korea, Africa, and Central America.

Of the 88.6% of students applying from universities in California, about 82% graduated from the University of California (UC) system of 9 campuses (Figure 1a), 15% graduated from California State University (CSU) system of 23 campuses (Figure 1b), and the rest (18%) graduated from other California institutions. It is notable that two campuses in the University of California system (Berkeley and Davis) contribute nearly 50% of students applying to our postbac program. Not surprisingly, the two campuses are very close to our Hayward campus (Berkeley is about 22 miles away and Davis about 84 miles away) making distance, familiarity with area, our program's reach-out efforts in our catchment area, and word-of-mouth from peers, important factors in student

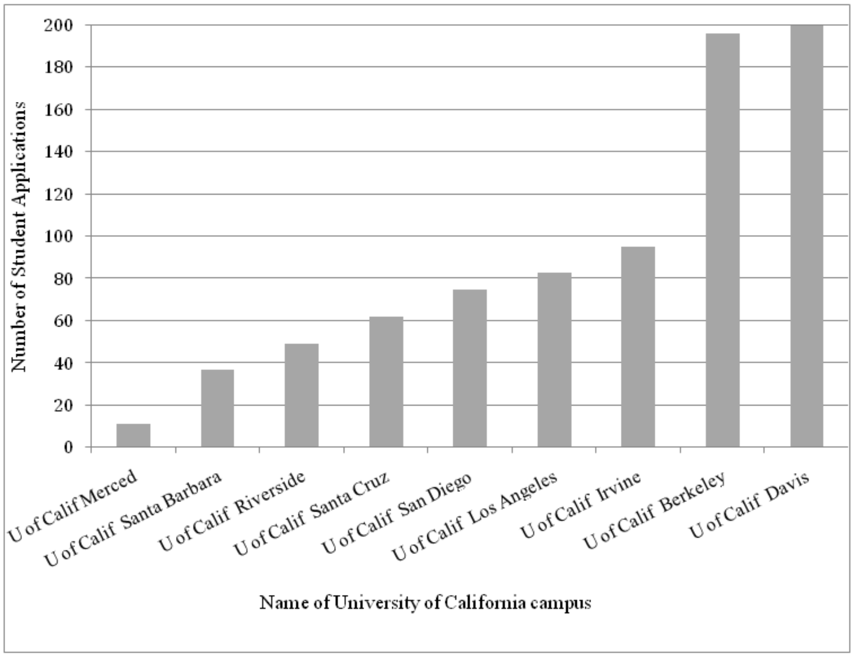


Figure 1a. Number of students applying from University of California campuses

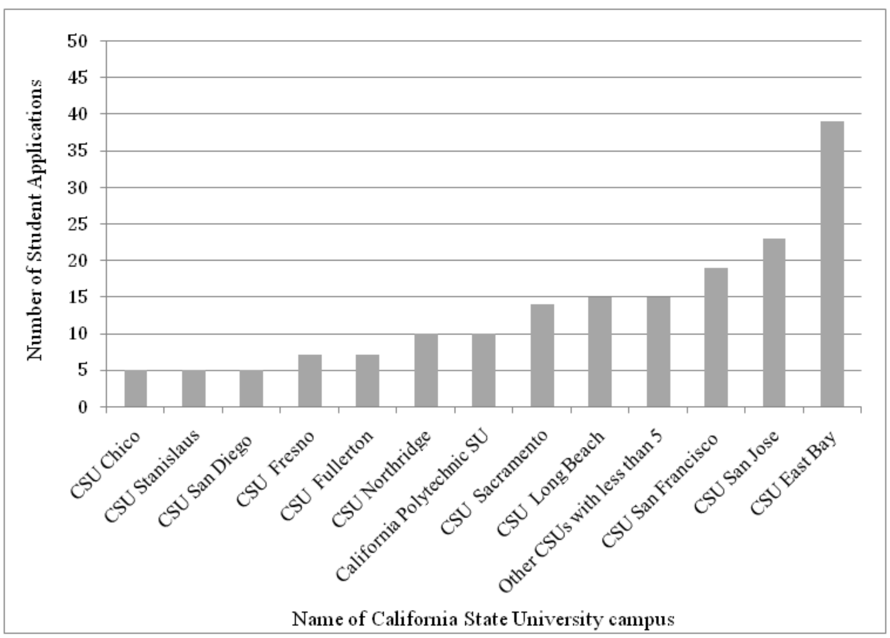


Figure 1b. Number of students applying from California State University campuses

choices. Past studies on student college choice have highlighted selection factors like academic reputation of the institution, campus resources, program size and quality, tuition, availability of financial aid, geographic location, and students' academic ability and achievement characteristics (Kallio, 1995; Poock & Love, 2001; Moring, 2007; Lei & Chuang, 2010). Other important factors mentioned include availability of information about

Table 2. Spearman's Rank Correlation analysis of undergraduate and postbac GPA data in both CC (n=138) and ADV (n=234) cohort students.

Scenario	***Correlation Coefficient***	***Probability***
Correlation between *undergraduate* and *postbac GPAs* in all students? (n=372)	0.31	P<<0.001
Correlation between *undergraduate* and *postbac GPAs* in career changer cohort students? (n=138)	0.38	P<<0.001
Correlation between *undergraduate* and *postbac GPAs* in advanced cohort students? (n=234)	0.31	P<<0.001

college, admission requirements, student academic aspirations, parental and peer encouragement, and saliency of potential institutions (Cabrera & La Nasa, 2000).

The observation that there are more students (8 of every 10 California graduating students) from the UC system than from CSUs and/or other California colleges is interesting, but not at all surprising for several reasons. One, students who join the UC system from high school often had higher GPA and SAT scores than those applying to other state colleges. Two, UC schools are often large campuses with a campus student population of 30-40,000 students on average. This means that average class sizes are larger than the US college average with up to 700 students typical in foundation science classes like biology, chemistry and physics. Student academic and counseling support to cater for such large student populations is often inadequate or far-stretched. In many science courses, most instructor support and instruction comes from current graduate student instructors (often called TAs or teaching assistants) rather than regular faculty. Inevitably, this means that most science students are not as well prepared to pursue graduate school programs as would be the case. Three, mainly due to inadequate counseling, students often do not fully comprehend (early enough) the rigor and competitiveness of graduate biomedical science programs; and the concomitant requirement for academic excellence through all college years. Four, is the availability of postbac programs in the vicinity. Through outreach efforts and peer word-of-mouth, many graduating students, understanding that applying to biomedical school programs requires a solid academic foundation, already know they have a second chance in a postbac program - as long as they "prove" their academic aptitude in such programs and continue an upward academic trend.

Career changers (CCs) are postbacs who graduate as non-science majors and advanced students (ADV) are those graduating as science majors. There is a weak but positive correlation between undergraduate and postbac GPAs for: a) all students ($r=0.31$, $p<< 0.001$, $n=372$); b) CC students ($r=0.38$, $p<<0.001$, $n=138$); and, c) ADV students ($r=0.31$, $p<<0.001$, $n=234$). (Table 2). There were also significant differences between the mean overall GPAs between undergraduate and postbac stages of student preparation both CC and ADV cohort students ($t=31.71$, $p<0.0001$, $n=372$, Table 3). Further separation to compare undergraduate and postbac GPAs for *only* CC cohort students and *only* ADV students confirmed the above significant differences in overall results ($t=12.62$, $p=0.0004$, $n=138$ and $t=31.19$, $p<0.0001$, $n=234$ respectively, Table 3).

The weak correlation is perhaps expected since at this stage in their academic preparation, most postbacs are performing at a superior academic level likely promoted by several factors. One, the sense of belonging most postbacs find in our program with like-minded peers (with similar overall objectives of eventually applying to biomedical professional schools). Two, small class sizes (averaging about 25 students) encourage closer peer and instructor interactions. Three, formal tutoring support for every course our program offers fosters teamwork and cooperativity amongst peers. Wong, Waldrep and Smith (2007) found that formal peer-teaching greatly improved medical student academic success as measured by GPA and US Medical Licensing Examination test scores. Four, previous collegiate experience allows postbacs to assimilate into the academic culture of any campus (including ours) more easily. Evidently, they have pursued this road before and thus understand the "drill" better than their undergraduate peers. Five, and perhaps most important, as discussed in the 'Introduction" section above, are personal factors including student's level of maturity, perceived risk with this second chance likely fueling individual initiatives, motivation and work ethic.

The average *undergraduate* GPAs for CCs (n=138) and ADV (n=234) cohort students, was significantly different ($t=5.11$, $p<0.0001$, Table 4).This may not be at all unusual since many students find foundation science courses with laboratory very challenging. It could be a result of insufficient high school preparation in the sciences; taking science courses too early in their college careers when many students are still adjusting to campus

Table 3. Paired t-test analysis comparing both postbac GPA data for both CC (n=138) and ADV (n=234) cohort students.

Scenario	***Undergraduate Mean***	***Postbac Mean***	***t-test***	***Probability***
Is there a difference between mean undergraduate and mean postbac GPAs for all cohort students? (n=372)	2.95	3.62	31.71	<0.0001
Is there a difference between the mean undergraduate GPAs and mean postbac GPAs in *career changer cohort students*? (n=138)	3.04	3.57	12.62	0.0004
Is there a difference between the mean undergraduate GPAs and mean postbac GPAs in *advanced cohort students*? (n=234)	2.88	3.65	31.19	<0.0001

life and new surroundings; poor student study habits; class sizes that are too large with upwards of 500 students; and not enough academic support services including tutoring, faculty consultation and poor self-advocacy amongst the student population.

The average *postbac* GPAs for CCs (n=138) and ADV (n=234) cohort students were also compared and no significant differences were found between the two means (t=1.97, p>0.05, Table 5).Since both CCs and ADV perform equally well in the program, it appears that undergraduate exposure to science courses may not impact on postbac (science courses) academic performance. The level of motivation, maturity, collegiate experience, good time management, self-testing, adaptability, ability to utilize available support resources fully amongst all postbac students, as noted by Wambuguh and Yonn-Brown (2013), perhaps explains this finding. This elevated academic performance amongst postbacs is not only expected but required for postbacs to ensure continued support from the program. As postbacs, there's an overwhelming need to "prove" their continued upward academic trend to biomedical school admissions committees with excellent postbacs GPAs and better standardized test scores. These tests include the Medical College Admission Test (MCAT) for pre-medical students; the Dental School Admission Test (DAT) for pre-dental students; the Optometry Admission Test for pre-optometry students; the Pharmacy College Admission Test (PCAT) for pre-pharmacy students; and the Veterinary College Admission Test (VCAT) for pre-veterinary students.

Our postbac students take a variety of foundation science (physics, biology, chemistry and mathematics) and upper division biology and biochemistry courses including genetics, biochemistry, immunology, microbiology, neurobiology, molecular/cell biology, anatomy and physiology, and endocrinology. Houglum, Aparasu and Delfinis (2005) report that among the predictors of academic success amongst pharmacy school students, demonstrating academic excellence in science prerequisites is critical. McCall, Allen and Fike (2006) note that advanced biology coursework (especially genetics, cell biology, immunology, biochemistry, and molecular biology) highly predicted academic success in pharmacy school.

Logistic regression analysis data for the various predictive scenarios (Table 6) indicates the following: 1) Students entering the postbac program with overall undergraduate GPAs between 2.80-2.99 are two-and-a-quarter times more likely (Odds Ratio =2.26) to get postbac GPAs of at least 3.7 (χ^2 = 13.61, p=0.0002, n=372) than those with lower undergraduate GPAs. 2) Students entering the postbac program with overall undergraduate GPAs of at least 3.0 are three times (Odds Ratio =2.75) as likely to get postbac GPAs of at least 3.7 (χ^2 = 21.64, p<0.0001, n=372) as those with slightly lower undergraduate GPAs. It is interesting to find that postbacs with GPAs of at least 2.80 are 2.25-3 times as likely to achieve a GPA of 3.7 or above in their postbac studies. Cumulative undergraduate GPAs of at least 2.80 indicate a student who is generally above average in academic performance and who, given a chance, can do much better. This finding supports this proposition.

Wambuguh and Yonn-Brown (2013) used a similar statistical analysis to predict final examination performance from regular quizzes, finding that students who had an average of 90% overall in their total lecture quizzes scores were 3 times more likely to get at least 90% in their final examination. Although this study had a sample size of 372 students, this analysis definitively indicates that many postbac and graduate programs accepting students to prepare for advanced (doctoral) graduate programs, may not discount prospective students with GPAs below (but close to) 3.0. Sack (2004) reports that when the UC system decided to increase

Table 4. Paired t-test analysis of mean GPA data for all students (CC and ADV cohort students, n=372).

Student Category	*Undergraduate Mean GPA*	*t-test*	*Probability*
Career Changer Cohort	3.04	5.11	<0.0001
Advanced Cohort	2.95		

Table 5. Paired t-test analysis comparing both undergraduate GPA data for both CC (n=138) and ADV (n=234) cohort students.

Student Category	*Postbac Mean GPA*	*t-test*	*Probability*
Career Changer Cohort	3.57	1.97	>0.05
Advanced Cohort	3.65		

their freshmen admission overall GPA from 2.8 to 3.0, at least 750 high school students were affected every year. Nationwide, prospective postbac students with GPAs between 2.80-2.99 may number in the thousands and deserve to be given a chance. Such considerations would help ensure a diverse pool of students with a continuum of skills that supersede the regular gateway metrics used by many biomedical school programs. This will also improve the overall experience of students accepted in such programs as a result of differences in state residencies, nationality, socio-economic status and under-represented/minority backgrounds.

The logistic regression model predicts the probability of the occurrence as a function of the independent variable(s), and thus can be used to predict the probability of a hypothetical postbac student accepted successfully getting a cumulative postbac GPA of 3.7 and above. To do this, the y-value obtained from the general equation (y = a + bX) is then converted into a probability between zero and one in an S-shaped curve using the function: $p = e^{a+bX}/1 + e^{a+bX}$. To calculate the probabilities of a hypothetical postbac student entering our postbac program from the cumulative undergraduate GPA using the probability function ($p = e^{a+bX}/1 + e^{a+bX}$), the following results were obtained (Table 7). The results of this study indicate that compared to everyone else's academic performance in the group, a student entering the postbac program with at least a 3.0 cumulative GPA has a 69% chance of attaining a cumulative GPA of at least 3.7 by the end of their first postbac program year (X=1). Those with undergraduate cumulative GPAs of between 2.80-2.99 have 62% chance of attaining a cumulative GPA of at least 3.7 by the end of their first postbac program year (X=1). Students with lower than 2.80 cumulative undergraduate GPA have only a 42% chance of attaining a cumulative GPA of at least 3.7 by the end of their first postbac program year (X=0).

The results of this study have also enabled the development of three probabilistic equations depending on the student cumulative undergraduate GPA. We found this somehow complex analysis (especially for those who are not very conversant with logistic regression analysis) necessary as an academic performance predictor as described below. Thus, a hypothetical student can use his/her cumulative undergraduate GPA to predict excellent academic performance with at least 3.7 cumulative GPA by the end of their first full year in the program. For example, using the derived equation (y = -0.35 + 0.82X) a student with an undergraduate cumulative GPA of say, 3.22, can expect his/her probability of attaining a 3.7 GPA in the program to be at least 69% by substituting the values in this equation using the general probabilistic function ($p = e^{a+bX}/1 + e^{a+bX}$). If the student's GPA was below 2.80 (then, X=0) and using the equation (y = -0.21 + 1.01X), the resulting probability would be lowered to 42%. This may not be as bad and is an optimistic assurance that the student can still do well in the postbac program with better engagement and readiness for *harder* work. As noted by others (for example, Zimmerman, 1997, 1998, 2000; Van Den Hurk, 2006; Wambuguh & Yonn-Brown, 2013) such students will need careful self-monitoring, continuous self-evaluation, timely adjustments to study habits as integral components of self-directed learning. Postbac students like those applying to our program bring a multiplicity of important personal traits like the ability to overcome adversity, tenacity, work and varied life experiences, and a relatively high level of maturity and responsibility compared to our undergraduate student pool.

Table 6. Logistic regression analysis of both undergraduate and postbac GPA data in all students (n=372).

Scenario Prediction	*Chi-square (χ^2)*	*Odds Ratio*	*Coefficient*	*Probability*
How well does earning a graduating cumulative GPA of between 2.80-2.99 predict student postbac academic performance (as measured by an overall postbac GPA of 3.7 and above)?	13.61	2.26	0.82	0.0002
How well does earning a graduating GPA of 3.0 and above predict student postbac academic performance (as measured by an overall postbac GPA of 3.70 and above)?	21.64	2.75	1.01	<<0.0001

Table 7. Probabilistic equation and function results of logistic regression analysis data for the three undergraduate cumulative GPA scenarios[1] (n=372).

Scenario	*Equation* y = a+bX	*Probability* $e^{a+bX}/1 + e^{a+bX}$
Undergraduate Cumulative GPA 3.0 and above	y = -0.35 + 0.82X [X=1]	0.69
Undergraduate Cumulative GPA 2.80-2.99	y = -0.21 + 1.01X [X=1]	0.62
Undergraduate Cumulative GPA below 2.80	y = -0.21 + 1.01X [X=0]	0.42

[1]*The probabilities in last column are those for achieving a postbac GPA of 3.7 and above given the scenario.*

Although a common trend in the last two decades, increasingly, factors other than academic aptitude (as demonstrated by GPA and standardized test metrics) are becoming a critical part of the admissions process for many advanced graduate and professional programs. Many authors applaud and reiterate the importance of this broad approach to student admissions. Powis (2010) argues in favor of taking into account non-academic personal qualities in the selection of biomedical school students and discusses some problems associated with a selection method based primarily on academic achievement. Kancel and Hezlett (2007) state that while GPAs and standardized tests predict subsequent student performance across disciplines; they note that student motivation and interest (critical for sustained effort in graduate school) must be inferred from various unstandardized measures like personal statements, letters of recommendation and interviews. Turner and Nicholson note that “in this age of decreased variability amongst candidates, and given the importance of being fair, consistent and transparent in our selection practices, it is imperative that additional appropriate selection tools are developed and evaluated. The future success of the selection process will depend on its ability to formulate and develop additional criteria against which to compare candidates.” (2011, p.9). This broad admissions approach is clearly validated by the recent 2015 changes to the Medical College Admission Test (MCAT) in the United States and Canada. According to the American Association of Medical Colleges (AAMC, 2014), the concepts tested in the new MCAT are “designed to test the knowledge and skills of tomorrow’s doctors” consistent with current “medical advancements, changes to the health care system, and the increasing diversity of the population.” (2015).

CONCLUSION

The academic performance of postbac students reported in this study has demonstrated that despite their undergraduate major focus (science or non-science) and/or academic adversity, students entering the program with at least a 2.80 undergraduate GPA improve their odds of attaining a cumulative GPA of at least 3.7 by two-and-a- quarter times (or 62% probability). Those with at least 3.0 GPA improve their odds of achieving a 3.7 by three times (or 69% probability). This is consistent with the study’s guiding hypothesis (presented on page 5). Factors that include sustained health career interest, high level of motivation, dedication and strong believe in hard work will produce a very attractive breed of promising candidates ready for biomedical school programs. At a time and age when biomedical school programs are highly competitive and do not have space for all well-qualified candidates, admissions officers will continue to use a variety of ways to evaluate suitable candidates who will translate into the kind of biomedical professionals required in the 21st century. Common metrics like GPA and entrance test scores will continue to provide a solid basis for selecting students with a firm academic foundation in required prerequisite science courses. Postbac students will continue to provide an avenue through which biomedical school programs can recruit talented candidates who have demonstrated sustained upward academic growth as well as bringing on board their exquisite personal traits and a variety of skills/experiences that stretch beyond just good metrics.

ACKNOWLEDGEMENTS

I would like to thank Ms. Amarjit Bath, a premed student at our campus, for assisting in the early stages of data analysis.

REFERENCES

Association of American Medical Colleges (AAMC). (2014). History of the MCAT2015 Exam. Retrieved fromhttps://www.aamc.org/students/applying/mcat/mcat2015/history/
Ackerman PL, Heggestad ED (1997). Intelligence, personality, and interests: Evidence for overlapping traits. Psychological Bulletin, 121:219–245.
Ahmed I, Bin Wan Ismail WK, Amin SM, Riaz S, Ramzan M, Husnain M (2012). In the quest of excellence: significance of quality for students, teachers and institution. International Journal of Academic Research, 4(1):148-153.
Akomolafe MJ (2013). Personality Characteristics as Predictors of Academic Performance of Secondary School Students. Mediterranean Journal of Social Sciences, 4(2):657-664.
Alfano H, Eduljee NB (2013). Differences in work, levels of involvement, and academic performance between residential and commuter students. College Student Journal, 47(2):334-342.
Cabrera AF, La Nasa SM (2000). Understanding the College-Choice Process. New Directions for Institutional Research, 107:5-22.
Chamorro-Premuzic T, Furnham A (2005). Personality and intellectual competence. Mahwah, NJ: Lawrence Erlbaum Associates.
Cheng W, Ickes W, Verhofstad L (2012). How is family support related to students' GPA scores? A longitudinal study. Higher Education, 64:399–420.
Conrad N, Party MW (2012). Conscientiousness and academic performance: A Mediational Analysis. International Journal for the Scholarship of Teaching and Learning, 6(1):1-14.
Dooden H (2008). Assessing test-taking strategies of university students: developing a Scale and estimating its psychometric indices. Assessment & Evaluation in Higher Education, 33(4):409–419.
Farsides T, Woodfield R (2003). Individual differences and undergraduate academic success: The roles of personality, intelligence, and application. Personality and Individual Differences, 34:1225–1243.
Fraser W, Killen R (2005). The perceptions of students and lecturers of factors influencing academic performance at two South African universities. Perspectives in Education, 23:25-40.
Goodman S, Jaffer T, Keresztesi M, Mamdani F, Mokgatle D, Musariri M, Schlechter A (2011). An investigation of the relationship between students' motivation and academic performance as mediated by effort. South African Journal of Psychology, 41(3):373-385.
Houglum JE, Aparasu RR, Delfinism TM (2005). Predictors of Academic Success and Failure in a Pharmacy Professional Program. American Journal of Pharmaceutical Education, 3:283-289.
Jannati Y, Khaki N, Sangtarashani EO, Peyrovi H, Nojadeh NA (2012). The effect of supportive counseling program on the academic performance of nursing and midwifery students. Contemporary Nurse, 43(1):113–120.
Kallio RE (1995).Factors influencing the college choice decisions of graduate students. Research in Higher Education, 56(1), 109-124.
Kancel NR, Hezlette SA (2007). Standardized Tests Predict Graduate Students' Success. Science, 315:1080-81.
Lei SA, Chuang NK (2010). Demographic factors influencing selection of an ideal graduate institution: A literature review with recommendations for implementation. College Student Journal, 44(1):84-96.
Malefo V (2000). Psycho-social factors and academic performance among African women students at a predominantly white university in South Africa. South African Journal of Psychology, 30:40-45.
McCall KL, Allen DD, Fike DS (2006).Predictors of Academic Success in a Doctor of Pharmacy Program. American Journal of Pharmaceutical Education, 70(5):1-9.
Meltzer L, Katzir-Cohen T, Miller L, & Roditi B (2001). The impact of effort and strategy use on academic performance: student and teacher perceptions. Learning Disability Quarterly, 24:85-100.
Moring M (2007). Deciding Factors: Ignite Your Faith.

Christian College Supplement, 66(3):88.
O'Connor MC, Paunonen SV (2007). Big Five personality predictors of post-secondary academic performance. Personality and Individual Differences, 43:971-990.
Poock MC, Love PG (2001). Factors influencing the program choice of doctoral students in higher education administration. NASPA Journal, 38(2):203-223.
Powis D (2010). Improving the selection of medical students. British Medical Journal (Overseas & Retired Doctors Edition), 340(7744):432-433.
Rienties B, Beausaert S, Grohnert T, Niemantsverdriet S, Kommers P (2012). Understanding academic performance of international students: the role of ethnicity, academic and social integration. Higher Education, 63:685–700.
Sack JL (2004). UC Board Raises Minimum GPA, Student Ire. Education Week, 24(6):19-22.
Sternberg R, Kaufman J(1998). Human abilities. Annual Review of Psychology, 49:479–502.
Thatcher A (2007). The relationship between lecture attendance and academic performance in an undergraduate psychology class. South African Journal of Psychology, 37:656-660.
Turner R, Nicholson S (2011). Reasons selectors give for accepting and rejecting medical applicants before interview. Medical Education.45:298–307.
Van Den Hurk M (2006). The relation between self-regulated strategies and individual study time, prepared participation and achievement in a problem-based curriculum. Active Learning in Higher Education, 7(2):155-169.
Wong JG, Waldrep TD, Smith TG (2007). Formal Peer-Teaching in Medical School Improves Academic Performance: The MUSC Supplemental Instructor Program. Teaching & Learning in Medicine, 19(3):216-220.
Wambuguh O, Yonn-Brown T (2013). Regular Lecture Quizzes Scores as Predictors of Final Examination Performance: A Test of Hypothesis Using Logistic Regression Analysis. International Journal for the Scholarship of Teaching and Learning, 7(1):1-10.
Zimmerman BJ, Kitsantas A (1997). Developmental phases in self-regulation: Shifting from process to outcome goals. Journal of Educational Psychology, 89:29-36.
Zimmerman BJ (1998). Academic studying and the development of personal skill: A self-regulated perspective. Educational Psychologist, 33:73–86
Zimmerman BJ(2000). Attaining self-regulation: A social-cognitive perspective. In M Boerkaerts, P Pintrich, M Seidner (Eds.), Self-regulation: Theory, research and applications (pp13-39).Orlando, FL: Academic Press.

International Journal of Academic Research in Education and Review

Related Journals Published by Academic Research Journals

IJEBM International Journal of Economic and Business Management (ISSN: 2384-6151)
IJELC International Journal of English Literature and Culture (ISSN: 2360-7831)
IJPSD International Journal of Political Science and Development (ISSN: 2360-784X)
IJALIS International Journal of Academic Library and Information Science (ISSN: 2360-7858)
IJARER International Journal of Academic Research in Education and Review (ISSN: 2360-7866)
ARJB Academic Research Journal of Biotechnology (ISSN: 2384-616X)
ARJASR Academic Research Journal of Agricultural Science and Research (ISSN: 2360-7874)
ARJPC Academic Research Journal of Psychology and Counselling (ISSN: 2384-6178)
ARJHC Academic Research Journal of History and Culture (ISSN: 2437-2196)

http://www.academicresearchjournals.org/IJARER/Index.htm