IMPLEMENTING A FLEXIBLE STRUCTURE IN UNDERGRADUATE SCIENCE CURRICULA

Melanie Jacobs
Faculty of Science
University of Johannesburg
South Africa
Email: melaniej@uj.ac.za

Deon de Bruin
Department of People Management
University of Johannesburg
South Africa

Fanus van Tonder
School of Higher Education Studies
Free State University
South Africa

Abstract–"*A proposal for undergraduate curriculum reform in South Africa: The case for a flexible curriculum structure*" (CHE, 2013) suggests a number of scenario (models) in order to increase the number of graduates nationally. For the past 20 years South African higher education institutions were expected to start implementing a number of new policies and to align their internal functions and structures more optimally towards increased access, student throughput and quality teaching and learning, amongst other policy indicators.

Since 1994, the SA government has been steering a radical transformation and restructuring of higher education, which kicked off with the White Paper on HE transformation (1995), the latter which formally culminated in the Higher Education Act 101 of 1997. Policies are generally developed in response to challenges, problems or inadequate progress in respect of nationally identified strategic goals or targets. Some policies are geared at national quality enhancement, in the process, establishing new national structures with dedicated terms of reference and responsibilities. Policies are thus created to bring about desirable change and are generally regarded as strong symbolic indicators of national intent (Bunting, 2008; Bunting, 2004).

This paper reports on a sample of national and institutional policies and the directives stemming from them. The pertinent emphasis on an increase in the participation and eventually the academic success of undergraduate students in Science programmes is linked to insights brought about by increasingly improved National Senior Certificate (NSC) results, especially over the last decade. The quantitative investigation compares the academic performance of 1563 main stream first year degree students with 2110 extended degree students in seven fundamental science modules at the University of Johannesburg. Mean values were compared and regression provided predictive value of the different modules on performance. The enquiry culminates in speculation on the implications that the above mentioned Flexible Curriculum Structure might bring about and the dataset investigate flexible curriculum in practice at the University of Johannesburg.

Keywords: Flexible curriculum**,** Policies**,** Widening access**,** Academic success in Science programmes

1. PURPOSE AND CONTEXT OF THE RESEARCH

The South African higher education landscape has transformed with every term of Ministry by influential policy declarations and revisions of existing procedures. The fifth minister, Dr Blade Nzimande, has published the Green Paper (RSA DHET) in 2012 and a CHE Task Team (CHE, 2013) has reported on the undergraduate curriculum reform in 2013. These two documents indicate massive transformation agendas with all the other policies (Hay & Monnapula-Mapesela in Bitzer, 2009, p.12).

The geo-political South Africa (SA) has moved from a higher education sector where racial inequalities were evident for almost 50 years as dictated by apartheid planners since 1948 (RSA DoE, 1999). White South Africans had more access to educational resources and opportunities than their Black, Coloured and Indian counterparts (Van Wyngaard & Kapp, 2004, p.185) and were over-represented in higher education (HE). The SA education (school and higher education) sector was fragmented along provincial and racial lines (Habib & Parekh, 2000, p. 39-51; Hay & Fourie, 2002, p.115-131). International universities were subjected to powerful forces of change with pressure to widen access, penetration of the market, accompanied by increasing public and societal demands and expectations, but in South Africa the apartheid era delayed these international trends. Colin

Bundy (2006, p.3) states that in South Africa, Higher Education "…remained largely insulated from the global climate change prior to 1994."

The purpose of this study is to review some of the policies that suggested radical changes in South African HE. To apply these policies this study investigates the implementation of extended programmes as a flexible undergraduate curriculum (CHE, 2013) as a response to widening access, improving quality and graduation rate, addressing scarce skills, enrolment management, emphasis on research and institutional governance.

2. MAJOR POLICY INITIATIVES IN HIGHER EDUCATION POST-1994

2.1 Theoretical framework

This investigation will interrogate the literature perspectives of different government policies that influence enrolment, teaching and learning and curriculum development in specific Science offering. The high drop-out and failure rate of students are costing the students and the government money, also waste time and resources (CHE, 2013). This investigation compared policies and provides evidence that the foundational provision model as stated in the Flexible curriculum model (CHE, 2013) could result in successful throughput of students in Science programme. The theoretical framework that underlies this quantitative inquiry relates to the literature perspectives and research goals to achieve via descriptive, exploration and predictive measurement. The descriptive nature of the research represents description of student marks at school and university level (first year) and describes policies stemmed on the success of students. The exploratory nature of the research is represented by the exploration of the policies and the predictive nature of the research represents the prediction of academic success when students exit the foundational provision phase.

The quantitative approach of the investigation compares student results before and in university first year and determines predictors of success and can be quantified and measured. This approach is therefore post positivist which presumes that an external reality exists independent from the researchers, but that this reality cannot fully be known (Heppner and Heppner, 2004, p143). This approach does not aim to generate theories, models, frameworks, guidelines or programmes that reflect absolute truths about the reality of the participants. The outcomes should rather be judged with respect to the usefulness (substantively and practically) of the findings it generates.

The first post-apartheid term of the SA Government (National Unity in April 1994) brought about transformation at every level of society, with a vision for "reconstruction and development". This government focused on the challenge of economic development, as well as social and political change which created high expectations for fundamental change within the Higher Education sector. The procedure to change processes was through policies, and therefore the following discussions of eight major policies pertaining to changing the organisational culture of the HE sector within the democracy in SA. The second is an outline of the significant implications in Science programmes which also serves as its fundamental roots in Engineering and Health Science curricula.

2.2 The National Commission on Higher Education (NCHE) report (1996)

The National Commission on Higher Education (NCHE, 1996) conducted a groundbreaking investigation, with a direct and long-lasting impact on subsequent policy deliberations. Recommendations made by the Commission had the potential to change the entire SA higher education sector. The following NCHE recommendations are most pertinent within the context of this study:

- "Successful policy must overcome a historically determined pattern of fragmentation, inequality and inefficiency" (NCHE, 1996, p.5). Increased participation to accommodate a larger and more diverse student population and address the shortage of students in the Sciences and related disciplines.
- "Successful policy must restructure the HE system and its institutions to meet the needs of an increasingly technologically-oriented economy" (NCHE, 1996, p.7). Higher education should produce graduates who are better prepared for the labour market and to meet societal needs.

Resulting from this report the implementation will challenge staff, governance and student success. In practice, it will probably take more than one generation to counter stereotyped effects in full.

2.3 The White Paper 3 on Higher Education Transformation (1997)

The Department of Education (DoE) published the White Paper 3 on Higher Education Transformation (WPHE) in August 1997 (RSA DoE, 1997a). This policy provides further impetus for the achievement of a uniform national Higher Education system. The policy places social broadening of the Higher Education sector (in terms of race, class, gender and age) at the forefront. The key to the social, cultural, and economic development of the country relies on the optimal accommodation of a diverse student population.

The relevant recommendations from the WPHE (RSA DoE, 1997a, p.8-10) explicitly expresses a future vision to increase democratisation and broaden participation (and provision) of Black, female, disabled and adult students. Flexible models of teaching and learning to accommodate a diverse and larger than before student population will have to be developed and proven mechanisms of academic development and support for students will be geared towards optimal academic success.

2.4 The Higher Education Act (Act 101 of 1997)

The WPHE (RSA DoE, 1997a) preceded and culminated the Higher Education Act in 1997, underpinning transformation at a national level. The proposed restructuring of the Higher Education landscape required this legislation to drive the change resulting in the mergers of several Higher Education institutions (HEIs) a few years later, while the interconnected nature of planning, governance and funding was also prominent. The Act provided the Minister with powers to enforce with increased government control, and gave new and unexpected meaning to the original desirable notion of cooperative governance.

One of the implications of the Act was the expectation that institutions were to provide successful and qualified students within an optimal period of time. The emphasis on the increasing academic success specifically of undergraduate students and even more pertinent in the scarce skills programmes challenged the Fundamental Sciences (Mathematics, Physics and Chemistry), constituting the basis of most Science, Engineering and Health Science programmes.

2.4 The National Plan on Higher Education (2001)

The second democratic Ministry of Education took the bold step of revealing greater transformation in HE with a declaration in the National Plan on Higher Education (NPHE) which proposed increased subsidy and greater institutional efficiency and effectiveness. Four principles underpinned the NPHE (RSA DoE, 2001a), summarised by Jacobs (2010) in an acronym "READ":

I. **Research** promotion (**R**): To "retain current research strengths and to promote the kinds of research and other knowledge outputs required to meet national development needs…" (RSA DoE, 2001a, p.60).
II. Increased **Equity** (**E**): To "…ensure that the student and staff profiles progressively reflect realities of South African society" (RSA DoE, 2001a, p.30). The NPHE specifically cautioned against unacceptably low levels of enrolment of Black students in SET programmes, which had to be addressed urgently.
III. Increased **Access** linked to Success (**A**): To "increase the number of graduates through improving the efficiency of the Higher Education system …" (RSA DoE, 2001a, p.14).
IV. Promotion of **Diversity** in the Higher Education system by means of mission and programme differentiation (**D**): To "ensure diversity in the organisational form and institutional landscape of the Higher Education system through mission and programme differentiation" (RSA DoE, 2001a, p.36).

These underpinning principles of the NPHE are particularly relevant to the widening of student access, simultaneously linking to increased student success, effectiveness and funding implications. The earmarked funds were to realise particular objectives such as access for poor students, supporting under-prepared students and building research capacity (NPHE, 2001a, p.10).

2.5 Restructuring of the Higher Education System in South Africa (2001)

Colin Bundy (2006, p.20) stated that the NPHE marked the end of "symbolic policy making". There was an urgency to "…ensure diversity in the organisational form and institutional landscape" and to "build new institutional and organisational forms and new institutional identities…" (RSA DoE, 2001b, p.12). In July 1999 Prof. Kader Asmal, announced that the shape and size of the Higher Education system "…cannot be left to chance if we are to realise the vision of a rational, seamless Higher Education system…" (RSA DoE, 1999). The task was to reduce the number of institutions and establish "…new institutional and organisational forms…" The restructuring would result in a reduction of the existing 36 universities to 21, by implementing institutional incorporations, mergers and closures (RSA DoE, 2001b). A table by Bitzer, (in Van Wyngaard and Kapp 2004, p.187), indicates the 'old' and 'new' envisaged Higher Education landscape (see Table 1 below):

Table 1: The Higher Education Landscape Pre-And Post-Mergers (Adapted from Bitzer in Van Wyngaard and Kapp, 2004, p.187)

INSTITUTIONS	Number of institutions before amalgamations, incorporations, mergers and closures	Number of existing or envisaged institutions in 2003
Technical colleges	152	51 clusters
Colleges of Education	94	0
Nursing colleges	35	17
Agricultural colleges	11	11
Universities & technikons	36	21
Total	328	80

The reduction meant 241 less institutions with the closure of all colleges of education, the reduction in the number of agricultural and nursing colleges with universities impacting on the landscape. It was strange that the department would close colleges of education and incorporate these into universities at a time of a serious shortage of teachers in Mathematics and Physical Science and this remains a great concern.

2.6 Student Enrolment Planning in Public Higher Education (2004)

The central premise underpinning the above mentioned national policies and projects is that the Higher Education system "…must be planned, governed and funded as a single national coordinated system" (RSA DoE, 2004, p.2). The student enrolment planning document (2004, p.2) emphasises planning, funding, and quality assurance. Enrolment planning in the SA HE sector was officially introduced by the Ministerial Statement on Public Higher Education Funding (RSA DoE, 2003). Three key factors informed enrolment planning namely, matching of enrolment plans with available resources, linking of the enrolment plans to national human resource and research priorities with an emphasis on scarce skills (Science and related fields) and enhancing quality, throughput and graduation rates. This includes the development of alternative programmes and support mechanisms in specific scarce skills areas mentioned. The funding according to the Classification of Educational Subject Matter (CESM) (RSA DoE, 2004, 2008) provides a weighting factor that corresponds with a qualification type. In Table 2 an example of government subsidy per student is provided.

Table 2: The Funding Grid for Teaching Inputs (Adapted from RSA DoE, 2003; RSA DoE, 2004; RSA DoE, 2008)

Funding group	CESM categories included in funding group	Weighting factors for Teaching inputs			
		Under-graduate	Honours	Masters	Doctoral
1	Education, Law, Librarianship, Psychology	1.0	2.0	3.0	4.0
2	Commerce, Communication, Computer Science, Languages & Social Sciences	1.5	3.0	4.5	6.0
3	Architecture, Engineering, Math- and Physical Education.	2.5	5.0	7.5	10.0
4	Agriculture, Fine Arts, Health-, Life & Physical Sciences.	3.5	7.0	10.5	14.0

According to Table 2, the subsidy for an undergraduate student in Law and Psychology (weight of 1) is less than for an undergraduate student in Health Sciences. The amount is only calculated based on the minimum study years for any qualification and HEIs are therefore competing to recruit students who will earn more comprehensive and faster turnovers for subsidy purposes. The Sciences, Engineering, Technology and Health Science (SETH) environment could generate more income but due to under preparedness more students fail or even drop-out (RSA DoE, 2004, p.5) and financial difficulties, inability to adjust to HE, lack of counselling, incorrect study habits, and immaturity (Bunting, 2004, p.73-94; Scott in Bitzer, 2009, p.21) also contribute to unsuccessful studies.

2.7 Green Paper for Post-School Education and Training (2012)

In 2009 the Department of Higher Education and Training (DHET) was established and this department brought all post-school education and training and separated HE from the Department of Basic Education (DBE). The Green Paper had a priority to address inequalities that still existed after 20 years of democracy placing a lens on Black graduates. Whereas only 12% of the SA higher education population comprised of Black students 1993 (NCHE, 1996, p.64), it increased sharply to 59% in 1999, 65% in 2002, and 79% in 2010 (CHE, 2013, p.39). The growth in Black student participation also introduced complications with retention and progress. Bundy (2006, p.12) notes that "…access gains also prove less healthy when measured against student success levels". A 'wasteful' number of enrolled students fail to complete their studies, there is a decline in retention rates, and dropout rates are as high as one out of five".

There was only 45% Black PhD graduates in 2008 and 41% of these are women (DHET, 2012, p.7), indicating the under-representation at the highest academic level. The low success rates and throughput with shortage of academics in scarce skills (DHET, 2012, p.10) still remains an issue. The redress of participation in higher education is improving with 80% Black representation in 2010 compared to 55% in 1994 (DHET, 2012, p.34) with a noticeable growth in SET graduation (5.5% per annum) but this is still not sufficient for economic development.

The impact of widening participation with more students entering the sector from poor households, rural schools and a high non-payment rate (DHET, 2012, p.36) prompts institutions to be innovative. In presenting high-quality undergraduate education "…universities should be supported in offering and mainstreaming four-year undergraduate degree programmes where necessary" (DHET, 2012, 36).

2.8 A proposal for undergraduate curriculum reform in South Africa (2013)

The above review addressed access, quality and restructuring but during the 20 years of democracy, the low graduation rate in South Africa continues to deter social and economic development. The task team appointed by the CHE determined that 25% of SA students graduate in regulation time (a three year degree in three years) (CHE, 2013, p.43); 29% of BSc students and 23% of BIng students graduate in regular time.

Success and failure in HE can attributed to "…a complex interplay of factors" (CHE, 2013, p.54-57). The factors affecting success are all inter-related but the report groups them in three categories namely, material factors (socio-economic background); affective factors (attitude towards studies, psychological and social support) and academic factors (response to the educational process and poor schooling). The problems in the SA schooling system will not change soon and HE will have to address the articulation gap between school and university (CHE, 2013, p.60). The nature of the articulation gap is complex with under preparation in subject knowledge, academic skills and literacy, approaches to learning, contextual knowledge and forms of social capital contributing to the deficits in the transition of students.

This specific report brings tangible solutions to the table. The report recommends that institutions need to reform and modify structures to provide more time ad curricular space that would provide for strengthening and enhancement of learning (CHE, 2013, p. 68). The task team warns HEIs not to re-teach school content but slowly initiate new students into the HE approach. Many assumptions

are made about prior knowledge and skills and by extending the time and curricular space students will be able to become more intellectually mature. The CHE (2013, p.95-96) suggests a flexible approach where students enter into a longer programme but those who show confidence and good progress could accelerate and be exempted The report acknowledges the deficits in the HE sector and proposes a pragmatic model to address access and quality. The foundational provision such as language abilities, quantitative literacy and attributes that 21st century graduates need would be absorbed in this four year B-degree or five year professional qualification.

2.9 Synthesis of Policy Influences on Higher Education in South Africa

In a study by Jacobs (2010, p.38) the review of post-1994 Higher Education policies indicate that these influence institutions to become seriously involved with student academic success. The eight policies discussed above converge into key strategic issues of concern namely steering access and flexibility. In a diagrammatic presentation the policy drivers are presented in the metaphor of a lens system converging and diverging light, as shown in Figure 1, adapted from Jacobs (2010, p.38).

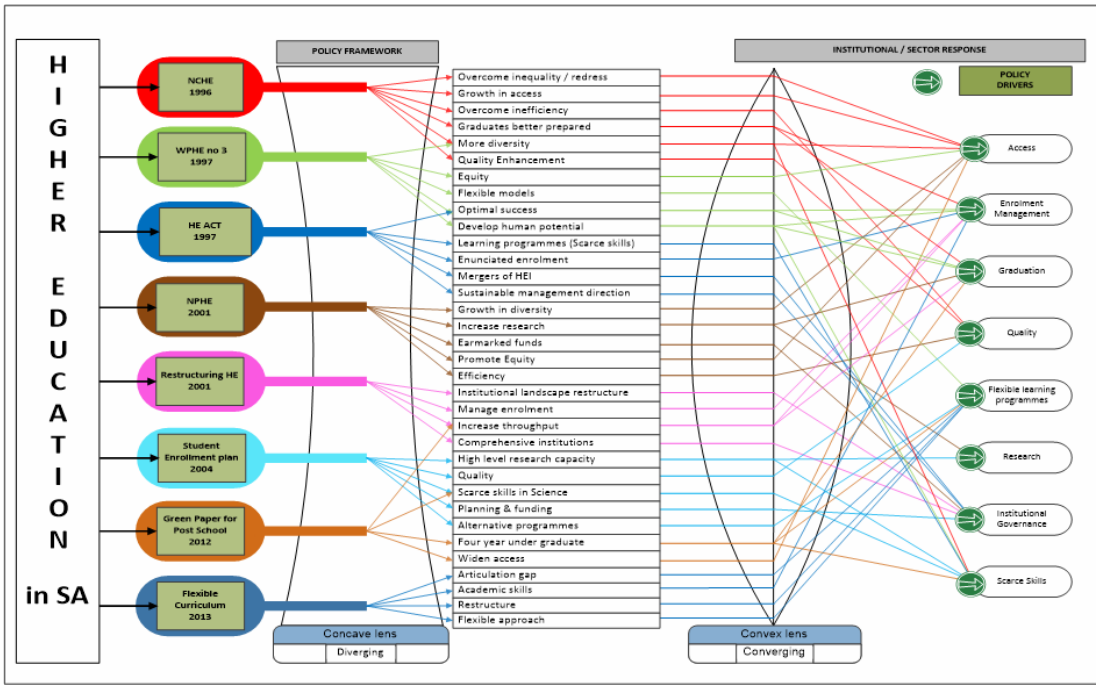

Figure 1: Policy Drivers Stemming From HE Policies
(Adapted From Jacobs, 2010, P.38)

The aforementioned policies challenge HE to respond, with the response presented as an optical lens system – "shedding more light" on the implications (the researcher's own presentation). In Figure 1, the HE system sends light rays via the eight selected policies represented by eight light sources. Each of these policies has emergent issues (shining from the light source) entering a concave lens, from where light is refracted in a diverging direction. These proposals represent light rays entering a second lens, namely a convex lens, which converges light rays to eight responses of higher education. The responses are policy drivers directing the suggested flexible curriculum to address enrolment management, access, graduation, and quality, alternate learning programmes, research, institutional governance and scarce skills.

The following section will discuss a few of the policy drivers (access, enrolment management, flexible management and scarce skills) applied in practice with extended programmes.

3. EXTENDED CURRICULUM

In the CHE report (2013, p.70-91) experiences and models of South African exemplar extended programmes are discussed. The origin of extended programmes was to provide alternative access and interventions to the non-qualifying students who did not meet admission requirements or to widen access for equity purposes. The programmes started to cater for the minority with the established "main stream" programmes continuing as if non-disturbed. The success rate for foundation courses ranged from 60%-80% (CHE, 2013, p.75), with SET students achieving a 74% success rate in foundation courses and 66% in regular courses. The DHET is really supporting SET programmes where students have challenges with content such as Mathematics, Physics and Chemistry, are being funded with a double weight. Every HEI has its own model to apply extended curriculum and receive foundational grants.

3.1 Extended Science programmes at University of KwaZulu-Natal (UKZN)

The CHE-report compares the performance in BSc extended and mainstream programmes for the 2005-2008 intake (2013, p.87) stating that 1200 students would not have been enrolled if there was no extended programme. The completion rate of the mainstream students was 59% for African, 54% for Indian and 68% for White students. The students from the "Augmented" programme (blended with mainstream) had a completion rate of 43% and those entering from the yearlong Foundation programme had a 31% completion rate.

3.2 Extended Engineering programme at University of Pretoria (ENGAGE)

The University of Pretoria (UP) started the Engage programme in 2010 with the five year BIng-programme and enrolled 291 students (CHE, 2013, p.88-89). About 65% of these students passed and went into the second year and then almost 60% went into the third year. Black students made up 35% of the ENGAGE enrolment with 71% retention in the third year. In comparison the mainstream enrolled 793 students in 2010 with 80% into second year and 73% in third year, with retention of 63% of the 25% Black students that initially started in the main stream.

3.3 Four year BSc degree programme at University of Johannesburg (UJ)

The University of Johannesburg (UJ) started an alternative access programme in 2004 with a year-long bridging programme and from 2006 the four year programme was designed to address the under preparedness in Sciences. In 2004, only 27.2% of the total intake in HE was in SET and of these only 26.1% graduated in regular time (Jacobs, 2010, p.107). Table 3 the profile of the enrolments in cohorts 2010-2013:

Table 3: Enrolment Figures: Main Stream & Extended (Faculty Of Science UJ, 2013)

Progr	Cohort	Total enrol-ment	Black participation	Gender		Mean GR 12 APS	Mean Gr12 Math	Passed all 1st mod	Failed all 1st mod
				M	F	%	%	%	%
MS	2010	570	75.9% (433)	57.7% (329)	42.3% (241)	34.46	71.14	45.3	19.5
	2011	543	81.4% (442)	56.4% (306)	43.6% (237)	34.54	69.02	46.0	24.7
	2012	392	73.2% (287)	55.6% (218)	44.4% (174)	35.74	68.21	48.4	18.6
	2013	398	79.6% (317)	61.3% (244)	38.7% (154)	35.47	68.03	54.4	11.3
EXT	2010	316	62.3% (197)	50.3% (159)	49.7% (157)	29.80	56.48	39.8	36.1
	2011	604	87.4% (528)	45.7% (276)	54.3% (328)	30.50	55.80	50.5	27.3
	2012	396	91.1% (360)	54.3% (215)	45.7% (181)	30.70	54.94	59.1	11.5
	2013	573	79.7% (317)	50.8% (291)	49.2% (282)	31.32	57.24	51.8	15.6

Table 3 demonstrates that more students are enrolled in the extended programme; provide access to more Black students and have a good female representation. The mainstream Grade 12 APS ranges from 34.5 to 35.7 and the extended APS ranges from 29.8 to 31.3. The Grade 12 Mathematics also indicates the difference with mainstream average above 68% and extended average of 54%. Many students fail modules during studies and when they pass more than 50% can continue with studies. The students who failed all the first semester modules range from 11% to 25% in the main steam and 11% to 36% in the extended. The extended programme does allow students to articulate from the mainstream to the extended programme after six months. The admission requirements as well as space limitations determine if students are placed in the mainstream or in the extended programmes.

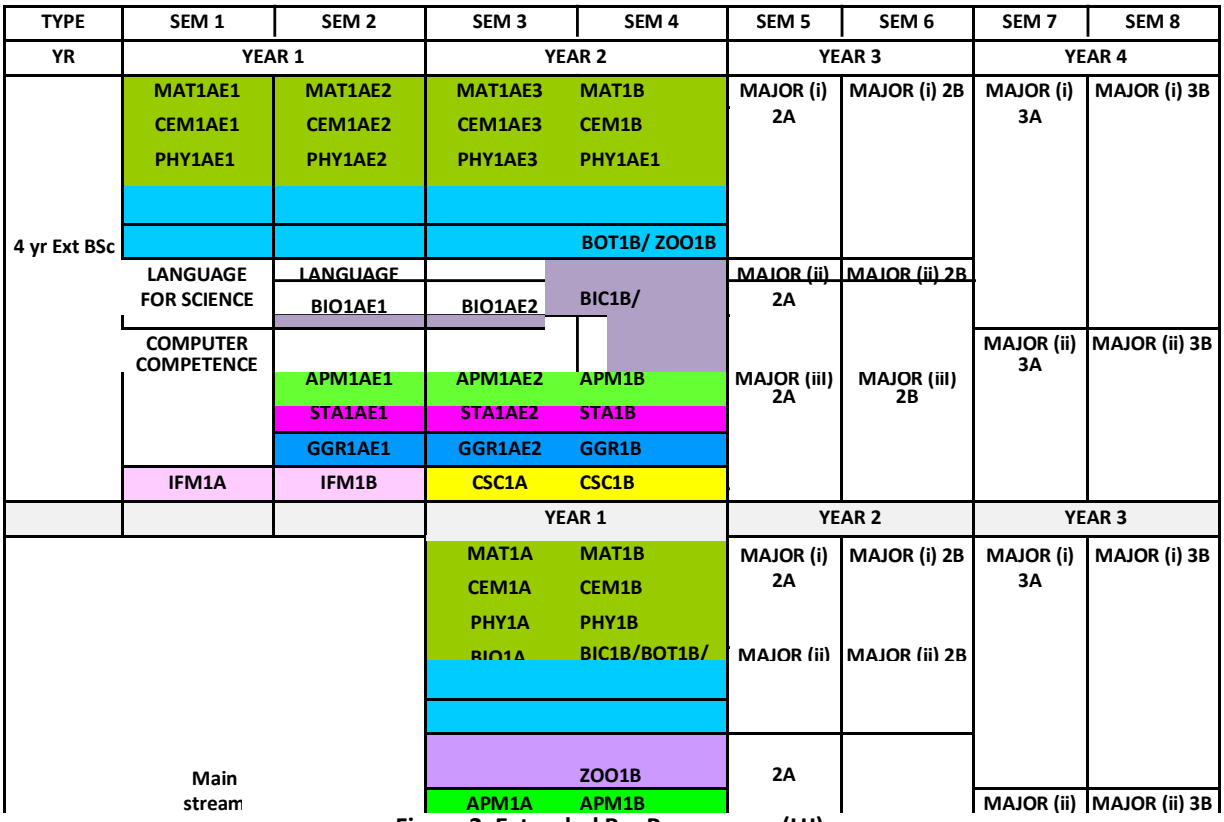

Figure 2: Extended Bsc Programme (UJ)

The design of the four year programme is shown in Figure 2 and consists of three semesters of foundational provision, smaller classes, dedicated lecturing and language and computer support. In the first semester all students register for Mathematics, Physics and Chemistry and the curriculum is based on fundamental and conceptual knowledge and skills development. After completion of the first semester the successful students continue with two semesters (covering the one main stream module) in Mathematics, Physics and Chemistry. It is only after the first semester that students choose fields of specialisation and then start with two semesters of Geography, Biology and Applied Mathematics. Thus, the students have three semesters before they register for the second semester (with main stream first years) and complete the entire first year curriculum.

4. RESEARCH

4.1 Research Methodology

The empirical component of this study adopted a quantitative approach, where the focus fell on comparing the performance of students in the three year (main stream) with students from the four year (extended) programme. All the students in the faculty (and Engineering and Health Sciences) register for the fundamental science modules (Mathematics, Chemistry and Physics). From this

perspective, the outcome of research may be judged with respect to the usefulness (substantively and practically) of the models and theories that it generates.

4.2 Research Purpose

The purpose of this investigation is to establish the progress of the students in the four year programme measured when the students from the two streams come together in the second semester (main stream) and fourth semester (four year). The assumption is made that there are many factors which influence progress and that more time and more space could be but two of the interventions that could contribute toward academic success.

The overarching goal of the empirical component is the identification of valid and reliable predictors of student success in Science modules. The following empirical research objectives are pursued in this study:

- To compare the performance in the final module of first year (1B) in Mathematics, Physics and Chemistry when the two streams join to write the same examination in the same time.
- To examine the predictive value of school performance in Mathematics with regard to success in first-year Science modules (e.g. Mathematics).

4.3 Participants

The target population included all first-year students registered for three fundamental Science modules (i.e. Mathematics, Chemistry, and Physics) at the University of Johannesburg in Gauteng, South Africa. Participants were drawn from the cohorts of first-year students registered for these modules in 2010-2013. These students were registered for programmes in the Faculty of Science but also serve as service modules to mainly the Faculties of Engineering and Health (1563 in the main stream and 2110 in the extended programme).

4.4 Data collection instrument

The data collected were the grade 12 profile of students entering university (school results and biographical detail) and university results within specific science modules (as captured from official results). The measurement tool was the results and therefore the instrument measured the performance at school or university level. The instrument had face validity (measured what it was supposed to measure). The instrument is reliable as it would yield the same results if the measurement is repeated.

4.5 Investigating progress in fundamental science modules

The focus of this study is on the three fundamental modules Mathematics, Chemistry and Physics. Table 4 reflects the total enrolments and success rates of the whole cohort registered in the three mainstream modules used in this investigation as well as the extended modules.

Note the class sizes differ from Table 3 since students from other faculties and repeaters are also in the same class. Students in the main stream have to pass the 1A-module and then proceed to the 1B-module whereas extended students complete 1AE1, E2 and E3 (only the first semester marks 1AE1 is indicated) and then all of them join in 1B. In Table 4 the success rates of the final sample is made up by students that progressed to the 1B modules, please note students that failed are out of the system and do not progress to the 1B module. The mainstream and extended students come from two different precursor modules (mainstream only module 1A in one semester and extended from three modules) and are all in the same module 1B indicated in the last column.

A further analysis of the 1B class indicates that the students from the extended have a fair chance of passing the module and in some cases the lecturers report that these students are the top students in the class. The extended students have a year and a half to adapt, they have foundational provision in language and computer competence and have compulsory class and tutorial attendance.

5. RESULTS

In Table 4 the descriptive statistics indicate the mean values of the different variables.

Table 4: The Success Rates in Main Stream / Extended Modules

DEPT	MS / EXT	N	Mean GR 12 MATH %	Mean Succ Rate MS MAT1A %	Mean Succ Rate EXT MAT1AE1 %	Mean Success Rate 1B % (sample size) (MS/EXT)
MATH	MS	615	72.93	54.82		58.59 (388)
	EXT	777	59.99		56.04	50.86 (211)
CHEM	MS	265	71.70	54.83		59.56 (140)
	EXT	455	60.06		54.35	57.67 (135)
PHYS	MS	179	75.80	51.41		56.39 (99)
	EXT	331	60.98		54.59	57.00 (28)
BIOL	MS	228	66.85	53.46		
	EXT	324	59.74		58.83	
BOT 1B	MS	69				64.91
	EXT	78				60.59
BIC 1B	MS	126				66.94
	EXT	92				62.66
ZOO 1B	MS	81				58.80
	EXT	53				58.15

* The descriptive statistical techniques were performed with SPSS (Pallant 2007).
* The significance levels, means and SD are available for the Chemistry, Physics and Biology modules but are omitted due to limitations to the length of this paper.

The **Mathematics** modules (both programmes) had significance levels of "*p* = 000". The first semester **Mathematics** (mainstream) has as expected lower Mean of 54.82 (*SD* = 11.855) than the first semester Mathematics (extended) Mean of 56.04 (*SD* = 10.297). In the second semester Mathematics both had a pass average Mainstream: *M* = 58.59, *SD* = 10.184 and Extended: *M* = 50.86, *SD* = 9.738 in the 1B module. The students from the extended stream have an equal opportunity to pass in the second semester and the three semesters prepared them for the challenges of mainstream curricula.

In a regression analysis revealed a statistically significant relationship between overall Grade 12 achievement and university achievement (Mathematics 1A). Table 5 contains the Pearson correlations between the variables of interest, whereas Table 6 reflects the relative contribution of Mathematics at school level towards the prediction of success in Mathematics 1A.

Table 5: Correlations of Mathematics 1A With Mathematics Gr 12 (Mainstream)

		MAT01A1	Gr12 Math
Pearson Correlation	MAT01A1	1.000	.384
	Gr12 Math	.384	1.000
Sig. (1-tailed)	MAT01A1	.	.000
	Gr12 Math	.000	.
N	MAT01A1	615	615
	Gr12 Math	615	615

Inspection of Table 5 shows that Mathematics 1A correlated most strongly with the Mathematics Gr 12 (*r* = 0.384) and that a statistically significant relationship between exists (*p* = 0.000).

Table 6: Regression Coefficients in Math 1A (Mainstream)

Model	R Program = 1 (Selected)	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.247[a]	.061	.060	11.496	.061	39.938	1	613	.000

a. Predictors: (Constant), GR12 APS
b. Dependent Variable: MAT01A1

Table 6 shows that Mathematics Gr 12 on its own accounted for 6.1% of the variance in Mathematics 1A (ΔR^2 = 0.061; F = 39.938; df = 1, 613; p = 0.000), thus the Mathematics at school level contributed significantly towards the explanation of student achievement in Mathematics 1A but is less than we expected.

Table 7 presents the regression equation as applied to a graph (*y=mx+c)* the following Mathematics 1A results would be indicated.

Table 7: Regression Equations for Achievement In Math 1A(Mainstream)

Regression line equation	**Gr 12 Math mark of x is predicted to be a y mark in Math 1A.**		**To get a Math 1A mark of y, a mark of x in Gr 12 would be sufficient**	
y = mx+c	x (Gr 12 Math)	y (Math 1A)	y (Math 1A)	x (Gr 12 Math)
Math 1A = .497 (Gr 12 Math) + 18.610	80	58.37	80	123.52
	70	53.40	70	103.40
	60	48.43	60	83.28
	50	43.46	50	63.16

The statistical regression equation if applied to students with 63% in Grade 12 would not have been passing Mathematics 1A (50%) (Table 7). Analysis of the mainstream 1A results 54 students would have failed with Grade 12 below 63% and in reality 149 of them failed. Thus other variables than Grade 12 Mathematics contribute so that these students failed although they had above 63% in Grade 12 and leads to follow-up research to be conducted. It also implies that all 153 extended students that did pass the Math 1B module would not have been enrolled for the module at all.

Empirical synthesis

The empirical investigation among the policies and mainstream and extended data generated the following noteworthy findings:

- **Admission requirements** (mainstream): Academics should interrogate the value of school results to determine who to place where and where to start teaching in Sciences
- **Extended programmes** (flexible curriculum): This should become a policy with aligned funding as fully subsidised programmes and part of the core activities should be a priority.
- **Extended programmes** (enrolments): Institutions should seriously consider placing more students in these programmes to ensure throughput and ultimate graduation.

4. IN CONCLUSION

Government drove widening participation and redress for 20 years and the CHE flexible curriculum provides a pragmatic solution for not only the dysfunctional schooling system in SA but also graduation and ultimately research (with more students feeding into post graduate programmes). The UJ-model provided substantial evidence that more students can pass in Science faculties if placed in extended programmes with more time and more space to mature.

REFERENCES

Bitzer, E. (Ed.). (2009). Higher Education in South Africa: A scholarly look behind the scenes. Stellenbosch: SUN MeDIA Stellenbosch.

Bunting, I. (2004). The Higher Education landscape under apartheid. In Transformation in Higher Education: Global pressures and local realities. 2nd ed. Pretoria: CHET Kluwer Academic Publishers.

Bunting, I. A. (2008). Centre for Higher Education Transformation (CHET). 2004. Transformation in higher education: Global pressures and local realities. 2nd revised edition. Pretoria: CHET.

CHE (Council on Higher Education). (2013). A proposal for undergraduate curriculum reform in South Africa: The case for a flexible curriculum structure. Pretoria: CHE.

Hay, H.R. and Fourie, M. (2002). Preparing the way for mergers in Southern African higher and further education institutions: An investigation into staff perceptions education. Higher Education 44(8):115–131.

Heppner, P.P., and Heppner, M.J. (Eds). 2004. Writing and publishing your thesis, dissertation and research. A guide for students in the helping professions. Belmont, CA: Brooks/Cole-Thomson Learning.

Jacobs, M. (2010). A framework for the placement of university students in science programmes. (Unpublished PhD thesis). University of Free State, Bloemfontein.

NCHE (National Commission on Higher Education). (1996). NCHE Discussion document: A framework for transformation. Pretoria: July.

Pallant, J. (Ed.). (2007). SPSS survival manual. 3rd ed. Berkshire: Open University Press.

RSA DoE (Republic of South Africa Department of Education). (1997a). Education White paper 3: A programme for the transformation of Higher Education. (General Notice 1196 of 1997). Pretoria: Government Gazette. Pretoria.

RSA DoE (Republic of South Africa Department of Education). (1997b). Higher Education Act of the Republic of South Africa, No 101 of 1997. Pretoria: Government Gazette.
RSA DoE (Republic of South Africa Department of Education). (1999). Call to Action: Mobilising citizens to build a SA Education. Minister Kader Asmal. July 1999.
RSA DoE (Republic of South Africa Department of Education). (2001a). National Plan for Higher Education. Department of Education. Government Gazette, Pretoria, RSA.
RSA DoE (Republic of South Africa Department of Education). (2001b). The restructuring of the higher education system in South Africa. Pretoria: Government Printer.
RSA DoE (Republic of South Africa Department of Education). (2003). Funding of Public Higher Education. Schedule to Higher Education Act
(Act No. 101 of 1997). Pretoria: Department of Education. November.
RSA DoE (Republic of South Africa Department of Education). (2004). Student enrolment planning in Public Higher Education. Pretoria: Department of Education.
RSA DHET. (2012). Green Paper for Post-School Education and Training. Pretoria: Department of Higher Education and Training.
University of Johannesburg. (2013). Enrolment report: First semester. Faculty of Science. (Unpublished report.)
Van Wyngaard, A. and Kapp, P. (2004). Rethinking and reimagining mergers in further and higher education: a human perspective. South
African Journal of Higher Education 18(1):185-201.