EFFECTIVE UNDERGRADUATE PRACTICES AND INTERVENTIONS PREPARING STUDENTS FOR HONOURS STUDIES IN BIOLOGICAL SCIENCES

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ABSTRACT-Due to what is often characterized as a leaky educational pipeline, students often either fail to qualify for university entrance or experience a great academic, cultural and social shock when they initially start their university studies. Students often terminate their studies before graduating mainly due to academic and socio-economic reasons. These reasons can be ascribed to a lack of career guidance and poor school preparation. In order to accommodate underprepared and often immature students entering higher education, the University of Johannesburg has implemented a flexible curriculum in the BSc degree programme. This curriculum recommends that adding an additional year to the conventional BSc-3-year degree (i.e. BSc-4-year degree), covering the same curriculum but providing intensified support, has proven to be advantageous to most first year students. Students entering the BSc-4-year degree programme will have the opportunity to complete one semester modules over two semesters. Thus ensuring more time to become accustomed to the challenges of the academic and social demands of higher education. This extended degree format, not only allows students to adapt to university life but also to become more mature, responsible students. Thus developing exceedingly successful students focussed on their study goals and aspirations to eventually enter into post-graduate studies and accomplish exceptional achievements.

Keywords: Flexible curriculum; Honours; Academic success in Science programmes; Intervention programme

1. INTRODUCTION, CONTEXT AND PURPOSE

Academic performance and optimal preparation for the challenges of the following year have been discussed in various forums around tables in school and university boardrooms, informally by concerned lecturers in coffee breaks and researched internationally (Giancola, Munz & Trares, 2008; Pascarella, Pierson, Wolniak Terenzini, 2004; Olive & Russ, 2010). In the South African context the primary and secondary schooling system, feeding students into higher education, has been changed by politicians and policy makers in order to open the access for broader participation (Spaull, 2014). In the research performed by Nic Spaull (2013) the poor performance of South African schools in comparison to the rest of Africa, provides a glimpse of the real state of schools and learner achievement especially in Mathematics.

The widening of access into university programmes and the ill-preparation of school leavers has urged South African higher education institutions to ensure that students are exposed to fundamental knowledge and skills in order to retain them in the programmes. There had been criticism by many academics in higher education that any changes to curriculum lowers the standards and keeps students in the system, who should have left the university without completion (Jacobs & Jacobs, 2013). The suggested Flexible Curriculum proposed by Prof Ian Scott (2009) has stimulated the sector to rethink academic offering which made sense, especially in Science. The performance of learners in Science disciplines and shortage of qualified teachers urged academics to provide solutions to increase the success rate and deliver competent students to post-graduate programmes. In a study by Engelbrecht, Harding and Phiri (2009), they compared the first year mathematics results of 924 students with their National Senior Certificate (NSC) mathematics results. The results revealed that the 924 students had an average of 78% for their grade 12 mathematics marks and only scored an average of 35% for their first mathematics test at university level. Nel and Kistner (2009) and Jacobs (2015) showed the noticeable inflation of the grade 11 marks that accompanied the application to university, compared with the final marks received for their Grade 12 NSC examination. The research performed by Jacobs (2010 and 2015), Nel and Kistner (2009) and Engelbrecht *et al* (2009) clearly

shows the weak correlation between the Grade 12 NSC results and performance at tertiary level and substantiated the need for an alternative to the 3-year degree offering.

Universities started employing the National Benchmark Test (NBT) (Yeld, 2009) to provide early identification of at-risks students. Many institutions followed either an augmented or extended model at undergraduate level (Grayson, 1997). Extended degrees in South African universities refers to degree programmes that allow for an *extended* minimum period to complete the qualification. The additional time awarded to these students is envisioned to allow them to overcome their under-preparedness as measured by their NSC as well as the NBT performance.

The purpose of this study is to investigate the contribution that the BSc-4—year degree programme (Extended) in Biological Sciences makes in the Faculty of Science H o n o u r s p r o g r a m m e s at o n e o f t h e largest public higher education institutions in South Africa. The inquiry is conducted in three (3) Honours programmes namely: Botany, Biochemistry and Zoology from 2013 to 2016, where 104 students have successfully graduated with an Honours degree. Answer will be sought to the following two (2) research questions:
Does the 4-year degree programmes provide students with foundational provision to be successfulin their post-graduate studies?
What is the contribution of the first year Biology- and Biology (Extended) modules towards the prediction for success in the various Honours programmes in Biological Sciences?

2. THEORETICAL PERSPECTIVES

2.1. Theoretical framework

University governance structures are challenged with admission of students, maintaining teaching and learning and assessment practices in order to qualify students and then producing graduates that meets the demands of the workplace or being prepared to pursue further studies. Admission requirements to enter Honours studies are based on performance of the third year majors within the field of choice (UJ, 2017). These requirements admits a student adhering to the requirements and probably aspires that all the students in the honours programme will continue to Masters and ultimately Doctorate programmes. According to the studies conducted by Scott (CHE, 2013) only 20% would possibly graduate in the minimum time (3 years for a Bachelor's degree) and 75% will have the risk of dropping out. The predictive model of Nelson, Nelson and Malone (2000) will serve as the theoretical lenses through which this specific study is viewed.

An investigation by Thompson and Korbrak (1983) suggested that prior assessments need to be conducted to assess potential risks that will impede academic success . This particular study highlighted that because of budget constraints and shortage of resources, institutions should spend more time, money and effort on more deserving students rather than wasting it on potential risk students. In the study performed by Nelson, Nelson and Malone (2000) to determine how institutions can select students most likely to succeed in university programmes, they compared various academic disciplines in terms of different skills and knowledge required. The predictive validity of the graduate grade point average (GGPA) used in the United States were considered for different disciplines and they found variations in the coefficients of correlation between different disciplines but concluded that the discipline in itself acted as the best predictor of success. In this investigation the Admission Point score (APS) which represents the NSC results, and first year Biology result, will be compared as predictive variables towards admission and success in three (3) Honours programmes.

2.2. The South African higher education dilemma

South African students entering university programmes were exposed to under-resourced schools for 12 or more years. The inequalities in teacher competence and provision has been amplified by Spaull (2013); with the Minister of Education (Spaull, 2014) reporting on the Annual National Assessment (ANA) and directly singles out inappropriate quality of teaching and learning throughout the entire school system and specifically in sciences related subjects. Furthermore the teaching and learning

strategies failed to provide the student with a strong foundation (CHE, 2013). It has been found that many of the students also struggle with the language proficiencies necessary for them to be successful graduates (Ratangee, 2006).

According to Boughey (2009), the extended programmes allow for students who do not meet the entry requirements of mainstream programmes, to be admitted and to complete their qualifications over a prolonged period of an additional year. The extra year is implemented to offer additional learning opportunities that will lay a sound foundation for academic success up to postgraduate level. The report of the CHE (2013) and the 1997 White Paper confirms this notion. In addition, the National Plan for Higher Education (2001) confirmed that government would provide funding for these extended programmes in order to encourage universities to implement it.

The primary focus of these 4-year programmes is to increase the academic success of students who are at risk of failing due to their poor educational backgrounds. The BSc-4-year programme in the Faculty of Science at the University of Johannesburg, allows for a slower pace of learning, making more time available to develop skills, numeracy and language competencies to be established. Extended programmes therefor ensures that these students receives the appropriate academic support to successfully complete their degrees (DHET, 2012). Research by Williamson, Pretorius and Jacobs (2014) has shown that programmes such as these are more successful as opposed to simply providing additional support during the first year of study. The BSc-4-year programme plays a significant role in allowing the students to make the transition from high school to higher education.

2.3. The Extended programme in Biological Sciences

The model that the university involved in this research consists of the following programme design and principles:

Programme design: The BSc-4-year programme mainly effects the first year of tertiary study. Chemistry 1, Physics 1 and Mathematics 1 are offered over a period of 18 months (3 semesters) and Biology 1, Geography 1 and Applied Mathematics 1 are offered over a period of 12 months (2 semesters). This differ from the Bsc-3-year programme, which offer all of the above modules over a six (6) month (1 semester) period. The curriculum of both programmes are the same with the exception of the first six months of Chemistry, Physics and Mathematics. During this time, the school curriculum is revised to ensure all the students are on the same level before commencing with new,more advanced tertiary level content.

Principles: The BSc-4-year programme gives students with a lower APS an opportunity to enter tertiary education. For the BSc-4-year programme, a student needs a minimum APS of 26 compared to the BSc-3-year programme, which require a minimum APS of 30. In the BSc-4-year programme, an additional language for science module is added to improve student's language and numerical proficiencies and skills. Smaller lecture classes with highly qualified motivated enthusiastic lecturers and additional compulsory tutorials, all contribute in the support given to these students to succeed. This invaluable support ultimately assist the student to an equal opportunity to pass their final year majors just as well as a BSc-3-year student. Furthermore, these students are also bound to pass the honours programme with equal opportunities provided in the undergraduate years.

2.4. The Honours in Biological Sciences programme

This research paper focused on comparing the success of students in the Botany, Biochemistry and Zoology Honours programmes with relation to their NSC results and their Biology module marks in first year. Students are admitted into the first year with marks from school and admitted into the Honours programme with marks from their third year majors. In Botany the Honours programme grew from three (3) students enrolled in 2013 to 16 in 2017, an average intake of eight (8) per year, five (5) entering from the BSc-3-year- and three from the BSc-4-year programme. In Biochemistry the Honours programme had an average intake of 11 students per year, average seven (7) from the BSc-3-year- and

four (4) from the BSc-4-year programme. In the Zoology Honours programme 11 students enrolled in 2013 to only eight (8) in 2017 with an average intake of seven (7) per year entering from the BSc-3-year- and three (3) from the BSc-4-year programme. In total the three (3) programmes had a collective enrolment of: 27 in 2013 (n=2 from BSc-4-year-); 25 in 2014 (n=9 from BSc-4-year-); 24 in 2015 (n=11 from BSc-4-year-) and 28 in 2016 (n=12 BSc-4-year-). The three Honours programmes had 76 students enrolled from 2013 to 2016 with 71% (n=54) entering from the BSc-3-year programme and 29% (n= 22) entering from the BSc-4-year programme. In 2017 the enrolment was mirrored with 72% (n=26) entering from the BSc-3-year programme and 28% (n= 10) from the BSc-4-year programme.

In a comparison of the top achievers in the three (3) Honours programmes, it has been found that in Botany and Biochemistry 50% (6 of 12) are feeding from BSc-4-year programme and in Zoology 30% (3 of 12) are feeding from BSc-4-year programme. This indicates that these students has caught-up or overcome whatever fundamental needs they had in transition from school to first year and could enter the Honours programme and furthermore perform even at the level as top-achievers.

The undergraduate and Honours results, provided indications that students in the BSc-4-year programme benefitted from the longer time but also with interventions such as literacy and numeracy modules adding value up to honours level. The growth of the Honours enrolments and quality of students that the BSc-4-year programme provides to the Honours degree can be considered as highly effective in developing the students' academic competency for future postgraduate studies. The hypothesis formulated suggests that the BSc-4-year programme can be deemed as effective in cultivating the students' academic proficiency in postgraduate degrees. Furthermore, the purpose is to provide evidence towards the increased enrolment in the BSc-4-year modules.

3. RESEARCH DESIGN AND METHODOLOGY

3.1. Research paradigm and method

The research was conducted in a post-positivist paradigm where the reasoning is from the general to the specific and the researchers' attempts to measure reality (Ary, Jacobs, Sorensen and Walker, 2014, 25). The main paradigm relates to the quantification of the contribution that the BSc-4-year programme made on the enrolment and success rate in the Honours programmes in Biological Sciences. The research method is an explanatory study focussing on casual relationships between the variables.

3.2. Participants and sampling

A sample of 104 participants were investigated. These were the available cases of Honours students in three disciplines from 2013 to 2016 at the Faculty of Science of the University of Johannesburg. Biochemistry Honours have been the most popular programme with 41 students from 2013-2016, Zoology with 39 and Botany with 24 students.

3.3. Data collection, administration and capturing

The data collected was the results of students as provided by the lecturers and faculty office. The data was provided on Excel spreadsheets at the end of each years first semester (Biology for the BSc-3-year programme) and all the others were provided at the end of each years the second semester.

3.4. Data analyses

The data was analysed with the Statistical Package for the Social Sciences (SPSS, version 23) performing descriptive statistics, followed by cross-tabulations. Test statistics and ranks were compared followed by a stepwise linear regression analysis.

4. FINDINGS AND DISCUSSION

4.1. DESCRIPTIVE STATISTICS and CROSS TABULATIONS

In Table 1 the descriptive statistics are provided for the sample of Honours students.

Table 1. Descriptive statistics: APS, Biology, Major in 3rd year & Honours marks

	n	Mean	Std dev	Mdn	Mode
APS (3 yr)	70	38.29	10.161	38.00	36
APS (4yr)	34	37.45	6.755	37.00	37
Biol (3yr)	70	57.61	7.325	56.00	50
Biol Ext (4yr)	34	68.07	9.699	67.50	64
Major (3yr)	70	68.61	7.260	68.00	61
Major (4yr)	34	68.24	6.150	69.00	60
Hons (3yr)	70	66.11	6.296	65.00	65
Hons (4yr)	34	66.21	5.443	65.50	63

The mean values for the APS between 3-year- and 4-year degrees do not differ significantly, however the standard deviation indicates a narrow spread with regards to the 4-year option. In terms of the Biology modules (one semester in the 3-year and two semesters in the 4-year) the mean values differ noticeably. The opportunity for students to master the module over two semesters (in Biology Extended) provide these students with sufficient time to perform well.

In table 2 the cross-tabulation of the Admission Point Score (APS) and Study duration (3- or 4-year) are provided:

Table 2. Cross-tabulation: APS and study duration

			3yr degree	4yr degree	Total
APS Category	29 or less	Count	9	2	11
		% within duration	12.9%	6.1%	10.7%
	30-39	Count	30	22	52
		% within duration	42.9%	66.7%	50.5%
	40 -49	Count	23	8	31
		% within duration	32.9%	24.2%	30.1%
	50 or more	Count	8	1	9
		% within duration	11.4%	3.0%	8.7%
Total		Count	70	33	103
		% within duration	100%	100%	100%

In the 3-year degree 55,8% of the APS counts are between 29 and 39 in comparison to the 4-year degree where 72.8% has an APS below 39. Thus 44.2% of the students in the 3-year degree entered with APS higher than 40. In the case of the 4-year degree option, there were 27.2% with APS above 40. This correlates with the entry requirements being higher for the 3-year degrees than 4-year degrees.

4.2. TESTING FOR SIGNIFICANT DIFFERENCES IN THE 3-YEAR- AND 4-YEAR DEGREE PERFORMANCES

The non-parametric statistical technique, the Mann-Whitney U test, tests whether two (2) independent samples from the same population compare in terms of mean rank. This particular test was applied as data from one (1) subject cannot affect the data provided by another subject. Tables 3 and 4 present the test statistics and ranks for study duration (3 / 4 years) and Biology (including Biology Extended) marks.

Table 3. Test statistics in respect of both Biology and Biology extended modules

	Both Biology Modules combined

Mann-Whitney U	451.500
Wilcoxon W	2963.500
Z	-5.125
Asymp. Sig. (2-tailed)	.000
***Note*.** Test statistics = Grouping Variable: Duration* = Significant at the 99% level of confidence	

Table 4. Ranks in respect of both Biology and Biology Extended modules

	Duration	N	Mean Rank	Sum of Ranks
Both Biology modules	3 year	70	41.95	2936.50
	4 year	34	74.22	2523.50
Total		104		

The Mann-Whitney *U* test (Tables 3 and 4) indicated that the Biology performance of the 4-year degree students (*Mean* = 68.07) are better (99% confidence level) than the 3-year degree performance (*Mean* = 57.61). *U* = 451.500, *p* =0.000 and Cohen's effect size (*r* =.36) was in the medium to high interval (Milenković, 2011, 77), which implies that the finding also has moderate (to high) practical significance. Tables 5 and 6 present the test statistics and ranks for study duration (3 /4 years) and marks in the Honours programme (including Extended).

Table 5. Test statistics in respect of Honours programme (both from 3-year and 4-year programmes)

	Honours(both from 3-year and 4-year programmes)
Mann-Whitney U	1125.500
Wilcoxon W	3610.500
Z	-.448
Asymp. Sig. (2-tailed)	.654

***Note*.** Test statistics = Grouping Variable: Duration* = Significant at the 99% level of confidence

Table 6. Ranks in respect of Honours programme (both from 3-year and 4-year programmes)

	Duration	N	Mean Rank	Sum of Ranks
Honours (both from 3-year and 4-year programmes)	3 year	70	51.58	3610.50
	4 year	34	54.40	1849.50
	Total	104		

The Mann-Whitney *U* test (Tables 5 and 6) indicated that the Honours performance of the 4-year degree students (*Mdn* = 66.21) are comparable to the 3-year degree performance (*Mdn* = 66.11) (99% confidence level), *U* = 1125.500, *p* =.654. Cohen's effect size (*r* =.39) was in the medium to high interval (Milenković, 2011, 77), which implies that the finding also has moderate (to high) practical significance.

4.3. TESTING FOR SIGNIFICANT DIFFERENCES IN THE HONOURS PERFORMANCES

The final analysis is a stepwise linear regression to determine the contribution of APS, Biology and major result toward predication in performance in the Honours programme. The stepwise analysis proceeded in three steps: firstly the APS was entered, then the Biology and then the major result. The APS had no significance but the prediction of Honours performance through examination of the change in proportion of variance was explained by the Biology and major results respectively. Table 7 reflect the results of the 3-year programme and Table 8 reflect the results of the 4-year programme.

Table 7. Proportion of Variance in Honours results explained by Biology and Major results in 3-year programme

Model	R	R square	Adjusted R^2	SE	Change Statistics				
					ΔR2	ΔF	df1	Mean square	Δp
1	.613[b]	.376	.367	5.009	2735.086	40.989	69	1028.626	.000[b]
2	.655[c]	.429	.412	4.827	2735.086	25.194	69	587.014	.000[c]

a. Dependent Variable: Hons 3-yr
b. Predictors: (Constant) Major 3-yr
c. Predictors: (Constant) Major 3-yr, Biol 3-yr

Table 7 shows that the Major on its own accounted for 37.6% of the variance in Honours performance ($R^2$0.376; F = 40.989; df = 69; p = 0.000), and that the Biology accounted for a further 5.3% of the variance (R^2 = 0.429; F = 25.194; df = 69; p = 0.000).

Table 8. Proportion of Variance in Honours results explained by Biology Ext and Major results in 4-year programme

Model	R	R square	Adjusted R^2	SE	Change Statistics				
					ΔR2	ΔF	df1	Mean square	Δp
1	.682[b]	.072	.448	3.795	834.242	26.938	69	387.880	.000[b]
2	.733[c]	.537	.506	3.587	834.242	17.413	69	224.085	.000[c]

a. Dependent Variable: Hons 4-yr
b. Predictors: (Constant) Major 4-yr
c. Predictors: (Constant) Major 4-yr, Biol 4-yr

Table 8 shows that the Major on its own accounted for 7.2% of the variance in Honours performance (R^2 = 0.072; F = 26.938; df = 69; p = 0.000), and that the Biology Extended accounted for a further significant 46.5% of the variance (R^2 = 0.537; F = 25.194; df = 69; p = 0.000).

5. IN CONCLUSION

Answers were sought for the two (2) research questions:
Does the extended degree programmes provide students with foundational provision to be successful in their post-graduate studies?
What is the contribution of the first year Biology- and Biology (Extended) modules towards the prediction for success in the various Honours programmes in the Biological Sciences?

Based on the Honours students' academic achievement compared with their performance in the BSc-4-year degree programme, the positive impact of the flexible curriculum has been statistically proven to be 46.5% of the performance in the Honours programme in comparison to the 5.3% contribution of Biology in the BSc-3-year degree programme. This paper thus provided the evidence that students entering from the BSc-4-year programme have acquired the skills and knowledge to be successful in an Honours programme and successfully complete a postgraduate degree in Science. Additionally the 4-year degree programme students excel in the various Honours programmes with many forming part of the top-3-achievers.

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