

## **A Comparison of Performance between the Former Science Foundation Programme Students and the Direct Entry Students**

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*In Namibia, Science Foundation Programmes (SFPs) are mainly designed to increase access to university science degrees for students from disadvantaged and/or marginalized groups. The programmes target students who are interested in a science degree programmes but do not meet the entry requirements through the normal Grade 12 examinations. In 2012, six years after the introduction of the SFP, a tracer study was conducted, involving a total number of 479 students, enrolled in the programme between 2005 and 2010. The tracer study used a combination of quantitative and qualitative methods but for the purpose of this paper, the quantitative results are presented. The data analysis revealed that even though the student population increased in number, starting from 2007 onwards, only 272 out of 479 students were enrolled in science degree programmes. The remaining number of students, about 96 (or 20%) of the participants, did not appear on the UNAM records. It was expected that all SFP graduates would have performed the same as those students who had a direct entry into the same programmes. However, an in-depth analysis of students' performance, in first year science core courses of mathematics and physics, indicated that for the first two years (2006 and 2007) there was a significant difference in performance, with former SFP students having outperformed the direct entry students. Nonetheless, graduates from subsequent years (2008 -2011) showed no significant difference in performance in either mathematics or physics between SFP and direct entry students.*

**Keywords:** *science foundation programme; direct entry; disadvantaged/marginalized students; educational data mining, first year students, degree programmes.*

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### **1. INTRODUCTION**

Universities across the globe use foundation programmes as alternative entries to assist, especially the minority, marginalized and disadvantaged students to qualify for university education by providing them with the necessary skills and knowledge required to undertake undergraduate studies. Tracer studies are becoming important in Namibia. In 2011, the National Commission of Higher Education (NCHE) conducted a tracer study on graduates of publicly funded institutions. In addition, the Namibian College of Open Learning conducts tracer studies on its graduates on a yearly basis (Fentiman, 2007; SAIDE, 2013). The tracer study of former SFP graduates is the first conducted by the University of Namibia.

The University of Namibia (UNAM) Oshakati Campus, formerly known as the UNAM Northern Campus, was established in 1998. The mandate of the campus was to extend access to UNAM through the development of undergraduate programmes that would improve the socio-economic status of the people of the central northern regions. However, UNAM noted that not many students graduating from secondary schools of the north central regions qualify for direct entry into many of the university programmes, especially in the science related programmes (Ngololo & Nekongo-Nielsen, 2012). As a result and with funding from the Ford Foundation, the Oshakati Campus introduced the Access Course, a university entry programme, between 2000 and 2004. The Access Course required students to retake the International General Certificate Secondary Education (IGCSE), thereby enabling them to gain admission at any institution of higher learning. The Access Course was transformed into a Science Foundation Programme (SFP) in 2005.

UNAM developed the one year Science Foundation Programme, structured around providing basic science and academic skills to enable students from the marginalized communities to enter UNAM and succeed in the Science related undergraduate programmes. The SFP, as a University of Namibia Senate approved bridging course, commenced in the academic year 2005 at the UNAM Oshakati

Campus. The aim of the SFP is to widen access, equity and equality to higher education to previously disadvantaged and/or marginalized groups by giving them an opportunity to enroll in science-related degree programmes at UNAM. Unfortunately, the interpretation of the concept ‘disadvantaged schools’ is not well recorded by the university.

Nonetheless, the specific objective of the UNAM Science Foundation Programme is to ‘develop the study and life skills of students, with the purpose of providing them a solid grounding for future university studies’ (UNAM, 2014).

Typically, foundation programmes are of one year duration and consist of science and academic literacy modules after which a student is expected to pursue science degree studies (Engelbrecht, Harding & Potgieter, 2014). The UNAM SFP is a one year preparatory programme offered to Grade 12 graduates who did not meet the university entry requirement but show potential to pursue a degree in the science-related fields. Those who are admitted to the programme are provided with foundational pre-university level modules, including Mathematics, Physics, Chemistry, Biology, English and ICT Literacy. In addition, the programme places a particular emphasis on developing study and life skills of students, with the purpose of providing them a solid grounding for future university studies. The criteria for admission are that:

- Applicants must be from disadvantaged schools as ‘defined’ by the University of Namibia;
- Applicants must have at least 17 points in Grade 12 with Grades E for Mathematics, Biology, English, D in Physical Science and in any other subject ; and
- Applicants must show good performance on placement tests in Mathematics and English, which tested their spatial ability, letter sequencing, numerical computation and reasoning.

By the end of the SFP, the students should have proven that their science and language are good enough for them to succeed in the science programme of their choice and have acquired sufficient study skills. This paper is an extract of the tracer study conducted by the authors in 2012, six years after the introduction of the UNAM Science Foundation Programme. The tracer study aimed at determining the performance of the Foundation Programme graduates in the first year of the different degree programmes at UNAM, in comparison to the performance of students who had a direct entry into the same degree programmes. Therefore this study is asking the following research question: Do the SFP students perform better in the core courses, specifically Mathematics and Physics, of the science degree programmes than the direct entry students?

## 2. LITERATURE REVIEW

Tracer studies have been conducted by educational institutions for decades, especially in assessing the relationship between school and/or university and the world of work and determining the factor of success (Zembere & Chinyama, 1996; Ugwuonah & Omeje, 1998; Schomburg, 2003; Umar, 2006). A number of tracer studies have been conducted in Africa, especially in Southern Africa (Zembere & Chinyama, 1996; Ugwuonah & Pmeje, 1998; Schomburg, 2003; Botswana Training Authority, 2005, 2010; Fentiman, 2007; NCHE, 2011; Oseifuah, Gyekye, NovisiKwadzo, Quarshie, 2014; Mugisha & Nkwasiwe, 2014). According to Balingbing (2014, p. 26) tracer studies are a “means to maintain curriculum relevance and provide targeted benefits to graduates to enhance marketability of educational programmes”. Tracer studies are conducted with the aim of providing quantitative structural data on employment, career, further studies and information on the professional orientation and experiences of former students (Schomburg, 2003; Millington, n.d.). According to the South African Institute of Distance Education (2012, p.3) “tracer studies should be appropriately timed to ensure sufficient time has elapsed and that the programme has kept good enough records to enable tracing to be conducted” and reliable data to be obtained.

A number of foundation programmes have been reviewed using tracer study approach in order to assess the success rate of such programmes (Engelbrecht et al, 2014; Campbell & Prew, 2014). According to researchers, the criteria to measure the success rate of foundation programmes mainly focus on achievement of pre-set learning objectives, including amongst other things, quality of teaching staff members; quality of students’ personal growth; completion rates; reducing risk of academic failure; articulation of programmes within other programmes of the university; passed all first year modules in the examinations; and subsequent graduation rates (Mills, Heyworth, Rosenwax, Carr & Rosenberg, 2009; Engelbrecht, et al., 2014). The tracer study of the UNAM Science

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Foundation Programme is being conducted five years after students from the first cohort completed the Programme and a year after they have graduated from the university. The criteria used to measure the UNAM Science Foundation Programme were the completion of the foundation programme and passing of the two core modules (mathematics and Physics) in the first year of the degree programme. Mathematics and Physics were the two subjects that were, in general, found to be 'problematic' and prohibited students from progressing further in their science degree studies (Ngololo & Nekongo-Nielsen, 2012).

Tracer studies on student passing first year modules and graduating on time have featured prominently in the literature (Naidoo, Flack, Naidoo & Essack, 2014; Jones, Coetzee, Bailey & Wickham, 2008; Letseka & Maile, 2008). For instance, a South African Study by the National Planning Commission found that universities were experiencing a large increase in number of ill-prepared first year entrants, especially in mathematics and science (National Planning Commission, 2011; Tsanwani, Harding, Engelbrecht & Maree, 2014). According to Jordaan, van Heerden and Jordaan (2014) if current teaching methods and curricula are inadequate to deliver the desired outcomes, irrespective of the reason for the mismatch, intervention strategies are desperately needed. Furthermore, Naidoo, et al. (2014) suggested more research to be done in determining academic success and performance, especially of previously disadvantaged students and those from rural areas.

### **3. RESEARCH METHODOLOGY**

The study employed an empirical paradigm to determine the academic success and performance of the SFP Students. A descriptive and correlational analysis of secondary data was conducted. A quantitative research design by mining data from the Integrated Tertiary System (ITS) using Oracle 9i software was used. The variables were the Student numbers, the Study Programme, Mathematics and Science scores and graduation data. In this study the researchers applied the non-probability purposive sampling in order to determine the academic success of the former SFP students within a population of all UNAM students. The unit of analysis comprised of all UNAM SFP students.

The students who graduated from the SFP were admitted into the same class with those who had the direct entry to UNAM science degree programmes. A total of 479 student records of the former SFP was traced for the years 2005 – 2010 and compared to that of all the enrolled students in the Science degree programme over the same academic period. The data was collated into a Microsoft Excel file, migrated and analysed with the use of the SPSS version 20.0 (SPSS, Inc., Chicago). Descriptive statistics was used to describe the data in proportions of all the students enrolled for Mathematics and Physics over that period. An independent t-test (Levene's test) was used to assess the equality of variance, whether a significant difference existed in the student performance from the two groups. The p-value of greater than the significance level of 0.05 was observed hence the assumption of equal variance is used.

### **4. PRESENTATION AND DISCUSSION OF RESULTS**

The findings show that some of the students failed to make it to the first year of undergraduate study programmes as they did not successfully complete the SFP, by obtaining less than 60%. Some of the students who failed to get into degree programmes were fortunate enough to get admitted into the diploma programmes at UNAM, the former Colleges of Education or at some Teachers' Colleges in Zimbabwe to become science teachers.

This section presents the results obtained from the quantitative part of the tracer study of those students who successfully completed the SFP and were admitted to the UNAM Science degree programmes. The SFP students' scores in Mathematics and Physics were measured against those students who had a direct entry into the first year of science degree programmes.

### **5. POPULATION OF FORMER SFP STUDENTS**

The student enrolment in the Science Foundation Programme, and the number of students who subsequently enrolled in the science degree programmes over the past five years (2005 -2010) are seen in table 1 below:

Table 1 shows that in total 479 students enrolled in the SFP over a period of five years (2005-2010). The SFP student population increased in number starting from 2007 onwards. Out of 479 students, 272 were enrolled in science degree programmes.

**Table1.** *SFP Enrolment between 2005 and 2010*

Year of enrollment in the SFP	Number of students enrolled in the SFP	Number of SFP admitted in the science degree programmes
2005	60	36
2006	60	47
2007	66	43
2008	73	42
2009	100	56
2010	120	48
Total Enrollment	479	272

## 6. COMPARISON OF ACADEMIC PERFORMANCE BETWEEN SFP AND DIRECT ENTRY STUDENTS

The results are given and discussed in the following sections.

**Table2.** *Physics and Mathematics class of 2006*

Subject	Code	No. of SFP students	No. Direct entry students	Average mark		Standard deviation	
				SFP	Direct Entry	SFP	Direct Entry
Physics	PHC3101	29	294	60.41	54.40	8.834	10.247
Mathematics	MTS3121	17	231	57.29	55.23	8.222	13.834

Table 2 shows that 29 students from the 2005 Foundation Programme and 294 from the normal entry were doing Physics. At the end of 2006, the class was assessed and on average, the SFP students scored a mark of 60.41 with a standard deviation of 8.834 whilst the students who entered through the normal entry had an average score of 57.29 with a standard deviation of 10.247. The table also shows that for those who took the Mathematics subject in the same year, 17 were from the SFP and 231 were from the normal entry group. These were also assessed at the end of the year and on average the SFP students scored a mark of 57.29 with a standard deviation of 8.222 whilst the students who entered through the normal entry had an average mark of 55.23 with a standard deviation of 13.834.

To assess whether there was a significant difference in the student performances from the two groups, the Levene's test was used to determine whether to use equal variance assumption or not and a p-value of 0.262 (p-value=0.262) was observed for the Physics class. The p-value is greater than the significance level of 0.05 hence the assumption of equal variance is used. A p-value of 0.021 was observed for the Mathematics groups hence the assumption of unequal variances was used.

**Table3.** *Significance test for mean difference*

Subject	Code	Mean difference	p-value	t-value	DF	Standard error of difference
Physics	PHC3101	6.009	0.003	3.047	321	1.972
Mathematics	MTS3121	2.060	0.357	0.940	23.292	2.192

Table 3 shows that there is a significant difference (p-value = 0.003) in the performance of the two groups in Physics. The SFP students performed significantly better than the direct entry students. In Mathematics, the SFP students performed slightly higher than those who had a normal entry but the difference was not significant (p-value = 0.357). This implies that the SFP students performed significantly better than the direct entry students in Physics but were not different in Mathematics.

**Table4.** *Physics and Mathematics class of 2007*

Subject	Code	No. of SFP students	No. Direct entry students	Average mark		Standard deviation	
				SFP	Direct Entry	FP	Direct Entry
Physics	PHC3101	37	246	63.97	59.55	8.918	14.220
Mathematics	MTS3121	26	144	54.08	52.49	11.869	12.842

Table 4 shows that, there were 37 SFP students and 246 from the direct entry doing Physics. At the end of 2007, the class was assessed and the average mark for the SFP students was 63.97 with a standard deviation of 8.918 whilst the direct entry students had an average mark of 59.55 with a standard deviation of 14.220. Table 4 also shows that for those who took the Mathematics subject in the same year, 26 were from the SFP and 144 were from the direct entry group. These were also assessed at the end of the year and on average the SFP students scored a mark of 54.08 with a standard deviation of 11.869 whilst the students who entered through the direct entry process had an

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average mark of 52.49 with a standard deviation of 12.842. To assess whether there was a significant difference in the student performances from the two groups, the Levene's test gave a p-value of 0.644 (p-value=0.644) for the Mathematics class. The p-value is greater than the significance level of 0.05 hence the assumption of equal variance is used. A p-value of 0.004 was observed for the Physics groups hence the assumption of unequal variances was used.

**Table5.** Mean difference for 2007 groups

Subject	Code	Mean difference	p-value	t-value	DF	Standard error of difference
Physics	PHC3101	4.424	0.012	2.576	67.351	1.724
Mathematics	MTS3121	1.591	0.557	0.588	168	2.707

Table 5 shows that there is a significant difference (p-value = 0.012) in the performance of the two groups in Physics. The SFP students performed significantly better than direct entry students. In Mathematics, the SFP students performed slightly higher than the direct entry students but the difference was not significant (p-value = 0.557). This implies that the SFP students performed significantly better than the direct entry students in Physics but were not different in Mathematics.

**Table6.** Physics and Mathematics class of 2008

Subject	Code	No. of SFP students	No. Direct entry students	Average mark		Standard deviation	
				SFP	Direct Entry	SFP	Direct Entry
Physics	PHC3511	13	121	49.54	46.98	10.806	15.867
Mathematics	MAT3531	11	133	50.36	50.88	10.519	13.543

Table 6 shows that, there were 13 students from the Science Foundation Programme and 121 from the normal entry doing Physics. At the end of 2008, the class was assessed and on average, the SFP students scored a mark of 49.54 with a standard deviation of 10.806 whilst the direct entry students had an average score of 46.98 with a standard deviation of 15.867. Table 6 also shows that for those who took the Mathematics subject in the same year, 11 were from the SFP and 133 were from the direct entry group. These were also assessed at the end of the year and on average the SFP students scored a mark of 50.36 with a standard deviation of 10.519 whilst the direct entry students had an average mark of 50.88 with a standard deviation of 13.543. The Levene's test was used to determine whether to use equal variance assumption or not and a p-value of 0.027 (p-value=0.027) was observed for the Physics class. The p-value is less than the significance level of 0.05 hence the assumption of equal variance is not used. It was thus assumed unequal variance for the t-test. A p-value of 0.241 was observed for the Mathematics groups hence the assumption of unequal variances was used.

**Table7.** The mean difference test

Subject	Code	Mean difference	p-value	t-value	DF	Standard error of difference
Physics	PHC3511	2.563	0.451	0.771	18.107	3.326
Mathematics	MAT3531	-0.516	0.902	-0.123	142	4.189

Table 7 shows that there was no significant difference (p-value = 0.451) in the performance of the two groups in Physics. In Mathematics, the SFP students performed slightly lower than those who had a normal entry but the difference was not significant (p-value = 0.902). This implies that the SFP students and the direct entry students performed the same in both subjects, namely; physics and mathematics.

**Table8.** Physics and Mathematics class of 2009

Subject	Code	No. of SFP students	No. Direct entry students	Average mark		Standard deviation	
				SFP	Direct Entry	SFP	Direct Entry
Physics	PHC3511	11	67	44.91	46.69	11.691	15.091
Mathematics	MAT3531	10	88	56.60	53.68	8.501	11.835

Table 8 shows that, there were 11 students from the Science Foundation Programme and 67 through the direct entry doing Physics. At the end of 2009, the class was assessed and on average, the SFP students scored an average mark of 44.91 with a standard deviation of 11.691 whilst the students who entered through the direct process had an average score of 46.69 with a standard deviation of 15.091. Table 8 also shows that for those who took the Mathematics subject in the same year, 10 were from the SFP and 88 were from the direct entry group. These were also assessed at the end of 2009. On average the SFP students scored a mark of 56.60 with a standard deviation of 8.501 whilst the direct entry

students had an average mark of 53.68 with a standard deviation of 11.835. The Levene's test was also used to determine whether to use equal variance assumption or not and a p-value of 0.340 (p-value=0.340) was observed for the Physics class. The p-value is greater than the significance level of 0.05 hence the assumption of equal variance is used. Additionally, a p-value of 0.373 was observed for the Mathematics groups hence the assumption of equal variances was also used.

**Table9.** *The mean difference test*

Subject	Code	Mean difference	p-value	t-value	DF	Standard error of difference
Physics	PHC3511	-1.777	0.711	-0.372	76	4.779
Mathematics	MAT3531	2.918	0.451	0.756	96	3.859

Table 9 shows that there is no significant difference (p-value = 0.711) in the performance of the two groups in Physics. In Mathematics, the SFP students performed slightly higher than those who had a normal entry but the difference was not significant (p-value = 0.451).

**Table10.** *Physics and Mathematics class of 2010*

Subject	Code	No. of SFP students	No. Direct entry students	Average mark		Standard deviation	
				SFP	Direct Entry	SFP	Direct Entry
Physics	PHC3511	16	210	53.38	53.31	16.186	16.430
Mathematics	MAT3531	14	165	58.79	53.12	12.577	14.713

Table 10 shows that, there were 16 students from the SFP and 210 from the direct entry doing Physics. At the end of 2010, the class was assessed and on average, the SFP students scored a mark of 53.38 with a standard deviation of 16.186 whilst the direct entry students had an average score of 53.31 with a standard deviation of 16.430. Table 10 also indicates that for those who took Mathematics in the same year, 14 were from the SFP and 165 were from the direct entry group. These were also assessed at the end of the year and on average the SFP students scored a mark of 58.79 with a standard deviation of 12.577 whilst the direct entry students had an average mark of 53.12 with a standard deviation of 14.713. To assess whether there was a significant difference in the student performances from the two groups. Levene's test was used to determine whether to use equal variance assumption or not and a p-value of 0.835 (p-value=0.835) was observed for the Physics class. The p-value is greater than the significance level of 0.05 hence the assumption of equal variance is used. A p-value of 0.365 was observed for the Mathematics groups hence the assumption of equal variance was also used.

**Table11.** *The mean difference test*

Subject	Code	Mean difference	p-value	t-value	DF	Standard error of difference
Physics	PHC3511	0.061	0.989	0.014	224	4.257
Mathematics	MAT3531	5.665	0.164	1.397	177	4.055

Table 11 shows that there is no significant difference (p-value = 0.989) in the performance of the two groups in Physics. In Mathematics, the SFP students performed slightly higher than the direct entry students but the difference was not significant (p-value = 0.164).

## 7. IMPLICATIONS OF RESULTS

The results indicate that on average students from SFP students performed better than the direct entry students in mathematics and better in physics during the first two years (2006-2007) of the SFP. However, in subsequent years (2008 – 2010) SFP and direct entry students showed the same level of performance, especially in Physics, with an average of about 50%. The higher performance noted among the SFP students during the first 2 years of the programme therefore signifies the importance of providing educationally marginalized students with foundation programmes to be able to make a better start in the first year of their science degree programmes.

However, when the curriculum of the Science degree programme was revised in 2007, a drop in performance in both subjects was noted from 2008 onwards for the two groups. The difference in performance between the cohorts can be attributed to the fact that in 2007 some changes were introduced to the curriculum. Through the revision, Mathematics 1A and 1B was changed to Basic Mathematics with slightly more content and the Foundations of Mathematics was changed to Pre-Calculus, with the new content including Analytic Geometry, Complex numbers and Matrices. As stated by Balingbing (2014) change in curriculum enables institutions to maintain curriculum

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relevance and enhance marketability of educational programmes. Nevertheless, in this case, the change in curriculum, particularly of the mathematics courses, might have caused the decrease in enrollment of the SFP students entering UNAM science degree programmes as noted in Table 1 above.

In this study it has also been found that SFP students have performed better in Physics (2006-2007) than the direct entry students but not significantly different. This better performance of the SFP students could be attributed to better teaching method and life skills approaches used in the SFP. It is noted that when pre-entry programmes that address both content as well as systematic issues such as educational structures and teaching as well as learning approaches are found to be beneficial to disadvantaged students, enabling them to make a head start and perform at the same level or even higher than the direct entry students (Radhakrishnan, Lee & Young, 2012; Ketim & Olowo, 2013; Engelbrecht, Harding & Potgieter, 2014).

The shortcoming of this study was that the two sample sizes were unequal with the number of direct entry students being much higher (over ten times higher) than the SFP students. As a result, the mean of the SFP has been negatively affected, making the comparisons more realistic for the larger group.

### 8. CONCLUSIONS AND RECOMMENDATIONS

The study reported in this paper set out to compare the performance between the SFP and direct entry students in mathematics and Physics as core modules in the first year of the science degree programmes. The study found that the Science Foundation Programme produced students who had the same performance as the direct entry students in mathematics and better or similar in physics. The outcome of this study also indicates a decrease in enrolment in the science degree programmes which could be a strength and/or weakness of the existing curriculum. It is therefore recommended that

- Similar studies comparing equal or nearly equal samples of students from the two groups be conducted.
- Investigation be conducted to find out whether the teaching methods used in SFP could enhance the performance in physics of both groups.
- The University use the revised mathematics and physics curriculum to inform the curriculum of the SFP.

Also, there still remains the question regarding the programme design and its implementation. Senate has not revised the design of the programme since its initial approval in 2005, yet the Faculty of Science continues to implement a selective strategy of only admitting into degree programmes students who have achieved 60% or higher on the Foundation Programme. This strategy was not part of the programme design when it was first approved in 2005.

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