A study of the possible existence, causes and effects of the Mathematical Knowledge Gap between High School and First Year University Mathematics Programmes and Possible Remedies for the Situation at UNIVEN: A case study

Abstract

Nearly for over a decade now the government of the Republic of South Africa has been trying to identify the existence or nonexistence, causes and possible remedies to knowledge gap between the knowledge possessed by school leavers and the knowledge required for first year entry into tertiary mathematics education through collaboration of efforts between the DoE, CHE, Universities, ASSAF, Schools and other interested organizations. The findings have, mainly, revealed that the gap exists and that some institutions had taken steps to bridge this knowledge gap, while others have continued to ignore the problem. This paper seeks to demonstrate that even if the findings may be seen as generally acceptable the UNIVEN case needs to be looked at as a unique one. The institution is rural based and as a result caters mainly for students from rural based schools with no adequate facilities and teachers. Even though the university is well situated to woe the best student from around its environs the reality on the ground points in the different direction. A scramble for the best performing students, which usually pits UNIVEN against other institutions in the country, renders UNIVEN's efforts to achieve her goals, to be at the center for rural development, useless. The investigations dwell on the real mathematical gap issues obtaining at UNIVEN. The intervention strategies, in particular by the university, to solve this problem are discussed.

Introduction

Internationally, there seems to be a growing discomfort in the way we prepare our students to face life in a world of technology and in particular on how we handle their mathematics learning taking into account that it is the engine of scientific progress**.** What has made our situation worse, virtually in all areas of studies, is the connectedness of almost all disciplines offered by universities as a response to societal needs. In the middle of the confusion is the discipline of mathematics. Every other discipline, now, seeks to utilize mathematics for clarity and accuracy of their subject development, investigative strategies and results. Now that mathematics is no longer the preserve of the gifted, with high aptitude for it, who joined the universities adequately prepared to deal with the subject in its high level of abstractness we find ourselves having to deal with diversified intakes of students. This is summed up by one of the authors in this area (Robyn Zevenbergen, 2001) who puts it correctly when he says "*In previous times, mathematics had been able to take the elite school leavers who were well prepared for their study of mathematics. However, such backgrounds can no longer be assumed*." This, therefore, poses serious questions about what is meant about the gap that exist between high school and first year university mathematics programmes. As a result this work seeks to define in what context we assume there is a gap, provide evidence of its existence by profiling UNIVEN situation through a detailed analysis of obtained data and offer suggestions for improvement.

In the international arena there is another dimension to this problem: this pertains to dwindling numbers of students opting to do mathematics at tertiary institutions and yet we concede that we have to do more mathematics in order to understand the world we are living in or perish.

Arguments along these lines can also be found in the report "Tackling the Mathematics Problem" commissioned by the London Mathematical Society (LMS, 1995). Clearly, this calls for double effort in detailing and studying the issues involved in the teaching of mathematics in schools and the appropriateness of the curriculum that we offer. The transition period thereof from high school to tertiary mathematics education is another area of great concern. A number of studies have been done on what mathematics needs to be taught and how it should be taught, at what level it should be taught, who should teach it, and who should be the recipients of what mathematical knowledge. Some of those critical studies have been carried out by Ye Yoon Hong et al., 2009, Engelbrecht & Harding, 2008. All this calls for a clear definition of what we call mathematical gap so that we can prescribe appropriate curriculum and provide proper training to those that must carry out the mandate.

In this study we assume the following meaning of the gap: '***The lack of smooth transition from high school mathematics to university first year mathematics for students majoring in science, mathematics and engineering due to the shortcomings of both the high school and first year university mathematics programmes'.*** That is, our understanding of the 'mathematical knowledge gap*'* in this study will be premised on this definition. Many studies have established the existence of this gap in general and what remains is to confirm it case by case in order to offer remedies based on the full knowledge of the nature of the gap for a particular situation in terms of how big it is and what appropriate intervention strategies could be used. If we can establish that there exists a discontinuity between the two curricula we then can conclude that there is a mathematical knowledge gap that needs to be filled. But, in order to understand that gap better we also have to discuss the causes of the gap which are, obviously, related to lack of sharing of ideas about each other's objectives of the programmes, and as a result our programmes are completely independent of each other.

To compound the difficulties faced by schools and universities offering mathematics education are problems related to facilities, workload, quality of teachers, quality of the curriculum, language proficiency amongst learners and many other factors. The medium of instruction in the feeder schools and at UNIVEN is English and yet there is a large group of students who are poorly prepared to handle the challenges of using the English language. Here we will not pursue language related difficulties in students, but instead we will simply factor it in based on other international and national studies which give reasonable estimation of the level of disadvantage due to lack of understanding texts and concepts as a result of language deficiency. Obviously, the consequences of this are the under-preparedness and underperformance by students. More involving studies on these problems are too theoretical for us to be able to rely on to deduce an easy analogy of the difficulties faced by students who have done English as a second language and are not quite conversant in expressing themselves in the language. An article by Boughey C., (2002) talks about students experiencing "*academic literacy difficulties*" rather than simply language problems and as a result insinuating that some language intervention programmes might not necessarily be all that appropriate in the South African scenario as an example. In another study by Barton, B. & Neville-Barton, P., (2004), carried out in New Zealand, the investigations revealed a 10% disadvantage in overall performance in first year mathematics for those students whose first language is not English due to lack of contextual understanding of the

subject. Some researchers have found out that there is a need to introduce the idea of language thresholds at university entry level (Clarkson, 1991, p. 13-14). At UNIVEN a pass in English is a requirement even though that pass may not be a guarantee of proficiency in English. Other possible contributing factors we are considering in this study are: poor facilities, lack of text books, lack of quality teachers, uninformed intervention strategies, accepting not so academically gifted students into our programmes, failure to provide career guidance before the students could make their choices and most importantly lack of knowledge of the existence of the knowledge gap by teachers and lecturers. As a measure of the contribution towards failure rate we consider language to be a factor in as far as other scholars like some of those mentioned above have concluded.

Of considerable importance are the important features of mathematical discourse. Due to high staff turn-over in the department estimation of pass rate and ability of the students to tackle mathematics of high complexity as a measure of student achievement is compromised. Pass rates vary from year to year mainly because a module is taught by three different lecturers of different backgrounds in four years. The reliability of such statistics is obviously reduced considerably due mainly to different approaches leading to emphasis being placed on different areas of the subject matter and the depth of teaching being compromised in some instances.

Formulation of the Problem

The problem is formulated on the basis that over quite some time now we have observed certain disturbing trends in the progression of students during either their Foundation year or first year of study and consequently during their advanced studies at this university. Students' performance in mathematics in general at UNIVEN can be described as good but when we look at these from one module to the other there is no clear answer. Students have performed well in some modules and badly in some other modules which indicates lack of consistency and continuity. This calls for an investigation into this inconsistency.

Clearly, the trends are not well understood here. Firstly, it is crucial to note that there is completely lack of communication between the unit responsibly for nurturing students through their Science Foundation Programme (SFP) and the mother departments, which in this case are mathematical sciences and physics departments. It is worthy noting as well that there is not a clear understanding of the so-called university entry tests for first entering students into various programmes requiring a pass in matric mathematics. The SFP is run almost like an independent, from the Mathematical Sciences Departments, unit. How then do they prepare students for our departments if they do not interact with the departments in terms of planning and teaching of their programmes? The idea of co-opting one or two staff members from the department to assist in the preparation of programmes is completely unsatisfactory since the whole project is supposed to be conceptualized by the department on the background of the problems the department wishes to solve in as far as underperformance in mathematics is concerned. The lumping together of students aspiring to do mathematics and those aspiring to do other disciplines needs to be interrogated. The study should reveal the existence /non-existence of the gap and in addition should seek to discuss the causes and effects of the gap. It should also come up with new strategies for improvement in the case of UNIVEN. A number of national and

international studies confirm the existence of the gap in general. Here we investigate the UNIVEN case by verifying and critically challenging some general results of such studies in our case and proffer some new ideas on how to improve on the schemes that are already in operation. The problem statement is summed up as: ***Possible existence, causes and effects of the Mathematical Knowledge Gap between High School and First Year University Mathematics Programmes and Possible Remedies for the Situation at UNIVEN***

Objectives

The main aim of this study is to establish the existence, causes and effects of the Mathematical Knowledge Gap between High School and First Year University Mathematics Programmes and proffer possible remedies to the situation at UNIVEN. The specific objectives are presented as:

a. To investigate the state of affairs at UNIVEN in connection with the existence of a gap defined above.
b. To justify the existence of the gap, if possible.
c. To study the causes and effects of such a gap in the case of UNIVEN.
d. To investigate transition process from high school mathematics to university mathematics at UNIVEN.
e. To proffer possible solutions to the gap problem.

In trying to address these objectives the study is divided into two phases. The first phase, presented in this paper, deals with the study conducted at UNIVEN which is meant to underscore the need for a broader investigation into this problem. It will address all the objectives but to a certain level of completeness. Further study will lead to visits to school and regional offices responsible for schools which supply UNIVEN with students. Also, some stake holders at UNIVEN will have to be consulted as it is felt that the gap has different meanings for different recipients of high school graduates with mathematics as part of their subject combinations at the university. On the basis of this study we are in a position to talk about the gap size and come up with a better perception of the issues on the ground. It is critical to know who is doing what and what kind of students we are presently dealing with and in what capacity.

Hypothesis and key questions

The study assumes that the knowledge gap exists but that it is not well defined especially in the case of UNIVEN. That is, the study assumes that the problem is not well understood even though we have had some intervention strategies in the form of the SFP which might have been a culmination of some research carried out, in general, for all South African universities. The argument here is that UNIVEN is unique in all respects: For example, as a rural based university and accepting the majority of its students from rural based schools warrants a special investigation in terms of its needs and ability to deliver.

The key questions to be asked are:

a. To convincingly establish whether the gap actually exist and how big it is to warrant serious intervention taking into consideration that there is a Foundation programme that is in place at the university, since 1999, which might have been established for that purpose.

b. To establish the effectiveness of the Foundation programme taking into account that up to date there has not been any scientific evaluation of the programme since its formation in 1999.
c. To whom should the Foundation programme be targeted: in response to the needs of those majoring in mathematics and those applying mathematics in their disciplines?
d. Does UNIVEN Foundation programme cater for the mathematical needs for other disciplines like engineering, business studies, etc.?
e. Who is under preparing the students?
f. Is the Foundation programme not a duplication of what the schools must do? If the answer is "Yes", we have a problem since the funds are being drawn from the same source, public funds, to do the same job.
g. Is the Foundation programme the best project that we can think of in terms of bridging the gap?
h. Who is teaching or rather who should teach our Foundation students?
i. What are the main objectives of the programme and do those that teach in the programme understand those objectives?
j. What kind of relationship should be established between the Foundation, and the Mathematics and Applied Mathematics Departments?
k. To what level does the Foundation mathematics programme articulate the needs of the Department of Mathematics?
l. Should the Foundation programme be declared a permanent feature at UNIVEN or not?
m. How appropriate are university entry tests, and who prepares them?
n. Has there ever been an evaluation of those tests in as far as their effectiveness is concerned here at UNIVEN?
o. To provide a detailed analysis of the progression of students from schools to the end of their first year at UNIVEN.
p. Is the language of instruction an issue to our students?
q. Should there be a threshold level of language proficiency that students of diverse backgrounds must achieve in order to allow maximum cognitive benefit for our students from the learning process?
r. Are there any gender issues to be addressed in how we conduct our teaching and on content to be delivered: for example in ensuring that there is no exclusion but rather there is inclusivity?
s. How does the need to address issues of appropriate content level, maintaining rigour, specialist and non specialist students and introduction of important problems which address directions in modern mathematics and its applications affect students' progression to advanced mathematical, engineering and other studies?
t. Is the problem universal in terms of the mathematics required for first entering students into main stream mathematics programmes compared to those doing service mathematics?
u. What is lacking in schools resulting in this gap? That is, to establish the adequacy of the curriculum and teaching aids, competency of teachers who implement the curriculum and availability of proper facilities in those schools. Do the teachers know what exactly the universities want in terms of preparedness of students when they enter universities?
v. How significant is the impact of differing mathematical backgrounds of students entering tertiary mathematics with regard to teaching, learning and the content to be offered?

w. As a rural based institution, do we have the same opportunities of attracting the best students, from the rural schools for example, as other well resourced institutions in the country?
x. What incentives are there to lure students to join us?

Methodology

The key questions listed above include the questions for the broader investigation. In this study we deal with questions a-o, which involve investigations at UNIVEN only. The scope of the second study will be extended to cover threats to the university's intended goals as a result of the gap. That is, it will look into the existence of outside factors as a cause of the gap and the ways how those problems could be dealt with.

This study covers the period from 2006 to 2010. Data for various aspects of this investigation may not necessarily be gathered over the same period for all the situations due to unavailability of such data in some cases.

In this study we have decided to do our analysis based on pass rates, and in particular module pass rate, rather than the graduation rate since we do not look beyond first year university programmes. The Foundation enrolment numbers and results over the indicated period are studied with a view of establishing how effective is our SFP in preparing our students for first year mathematics education in mathematical or physical science programmes. The criteria for setting up the SFP are interrogated in order to establish the actual purpose of the programme in terms of its targets. This kind of approach will reveal whether the gap issue ever existed in the minds of the planners of the programme and also the type of the gap that they were meant to bridge. In that regard we will show that high pass rate in that programme does not translate to minding the gap in terms of our understanding of the nature of the gap we should be dealing with.

The issue of transition requires that we look into the problems faced by both the lecturers and students in pursuing their goals of teaching and learning, respectively. Having assumed that the gap exist we confirm that there have been an attempt to fill in the missing stuff and that there have been comprehension difficulties regarding the progression from High School/Foundation progammes to first year fundamental mathematical modules. The details of the objectives of the SFP together with first year results in the fundamental mathematics modules confirm that. In that regard the study further uses the enrolment and examination success rate data to answer some of the questions being posed here.

The five year period might seem to be short to provide good evidence for our claims of the existence of mathematical knowledge gap; however, for reliability of the data this period is ideal. This also will enable us to easily identify the feeder schools after which we will visit them for verification of other vital information about how they conduct business in their schools pertaining to teaching of mathematics in our second phase of this study. There has been an allowance of putting the first time repeating students together with Foundation students for the purposes of comparison between straight entry students against Foundation students. This might collude our data, but our observation has shown that the repeaters are a very small, about 10% of the total, group to affect our investigations negatively. This assumption is based on 2 sampled

cases wherein the number of repeaters was only 6% and 8% of the total. The rest of the other categories of repeaters were considered as drop outs. Interviews were also carried out as a way of collecting vital data for this investigation. The study does not seek to establish the effects of knowledge of language(s) used as medium of instruction, but uses results of previous investigations by different national and international scholars on this topic. In other words, we rely on those studies to approximate the level of contribution towards poor performance by students as a result of language deficiency. Language deficiency is estimated to cause 10% disadvantage in overall performance, in science, through lack of contextual understanding. Barton, B. & Neville-Barton, P., (200) put it this way; " *Thus mathematical discourse is a mixture of characteristics that are peculiar to mathematics, and characteristics that derive from the natural language being used*." Simply put, it means that being able to master characteristics that are peculiar to mathematics is not enough to master concepts at the level of those who are first language speakers of the language of instruction. Other factors that also cause poor performance include proximity to the institution of learning and distressed state of mind amid high levels of poverty.

The data is then analyzed with a view of establishing a detailed truth about where we stand in as far as knowledge gap and remedial actions are concerned. The collected data are represented by tables to clearly depict key areas of this study. Of critical importance is the confirmation of the existence and effects of the gap for the students joining UNIVEN at Foundation/first year level and the analysis of the effects of the existence of the gap in terms of performance at first year level for various disciplines offered at UNIVEN.

As indicated above the study is split into two parts with the first part dealing with what happens at UNIVEN, i.e. what are our strengths and weaknesses in as far as running our SFP and first year programmes is concerned and the second part will look at the external forces at play, i.e. what threats are we facing as a result of situations which we are not in control of.

To deal with the first part SFP and first year students' data are collected to ascertain correct entry figures and success rate. The student/staff ratio which is considered to be too high at UNIVEN is used to justify how difficult it is dealing with the gap issues under the circumstances.

Results

The results being presented are based on a period of 5 years, that is, the period starting in 2006 and ending in 2010. The various situations are considered in various time intervals depending on the feasibility of those studies. Due to lack of data for some situations we could not deal with all the cases for the same period.

The results presented below are analyzed with a view of establishing the validity of or contradiction to our proposition about the mathematical knowledge gap between high school and university mathematics programmes, in particular the details are about the situation at UNIVEN. In order to ascertain whether the gap exits or not we have had to rely on international studies as well as our analysis of the programmes on offer at both high school and first year tertiary levels. From the international studies perspective we take into consideration that language plays a role in students' conceptualization of subject content which approximately is responsible for 10% disadvantage according to a study by Barton, B. & Neville-Barton, P., (2004). The majority of

our students have language problem. The other disadvantage is that of poor resources in schools, even though this is considered as an external factor and will be dealt with in the next phase of this work. Also, the inadequacy of resources in schools will be dealt with in the second phase of this project. Our Foundation programme has been analyzed, and compared to NSC curriculum document especially at grade 10 – 12 level and first year mathematics main stream modules at UNIVEN.

UNIVEN runs a SFP which is divided into two components known as Science Foundation and Science Enrichment Foundation Programmes. The programme was initiated by the university in 1999 and then later on taken over by the Ford Foundation in 2003 until 2006. The second cycle was followed by the third and present cycle which runs until the end of this year and is sponsored by DoE. The fourth cycle, also sponsored by DoE, is set to take off immediately after the third cycle in 20010 lasting three years. The former caters for students with matric exemption but without the school's required subject symbols in mathematics or physical science for instance. These students can register into the School of Mathematical and Natural Sciences to upgrade at least an F (SG) in mathematics or physics. The programme is not specifically targeted at those students wanting to pursue mathematics or physics or engineering as a subject, but for all those that aspire to do either mathematical sciences or physical sciences or environmental sciences or life sciences or agricultural sciences. In other words the kind of 'one size fits all' situation, which in our opinion is completely undesirable as it is unlikely to produce the desired outcome. The later caters for those students who are eligible to upgrade while also having three or so first year modules.

The Foundation unit operates as an independent entity: There is no defined plan of operation between the department of Mathematics and Applied Mathematics and the mathematics branch of the unit. The contents of the two Foundation modules FMT 1540 and FMT 1640 can correctly be put as equivalent to some topics at grade 10 – 12 levels, but do not address important topics which might be problematic at matric level. Topics like functions, sequences and series, differential calculus, Euclidean geometry, analytical geometry, vectors, complex numbers and statistics are not addressed in a way that minds the gap. Probably, the most appropriate thing, would have been to re-visit difficult matric topics and make extensions to those topics in order to smoothen the transition into first year modules. The programme does not meet the basic requirements of a bridging course because it is not informed by the need to fill in the gap but by the need to make the failed matric students enter the university through using another door. The syllabi documents for the Foundation progrmme and a sample of past exam papers were scrutinized for the purpose of estimating the level at which they are operating. The lecturers were also interviewed, but unfortunately there has been a high staff turn-over in the unit to the extent that those present now could not offer any meaningful details about the programme. The finding that the programme does not meet the required standards is premised on the above reasons and most importantly because it is not targeted and takes students with ridiculously low matric passes in mathematics. It can not therefore be considered as a preparatory programme for university mathematics or science or engineering programmes.

In this study we have decided to make our analysis based on pass rates, and in particular module pass rate, rather than the graduation rate since we do not look beyond first year university programmes. Judging from the module pass rate the FMT 1540 and FMT 1640 students have

been doing very well over the period of 4 years from 2007 to 2010. (see Tables. 1 &2 below). Whether this translates to improved level of understanding of the subject as well as improved preparedness of the students to undertake university mathematics courses in mathematical sciences or physical sciences or engineering is the question to be asked. The varying enrolled student numbers seem to have had a slight effect on the pass rate. Pass rate is better in the case of smaller numbers of students as compared to larger numbers. The small numbers enrolled in 2009 and 2010 were as a result of a programmes rationalization exercise that was carried out by the university in 2008 and implemented in 2009. The recommendations were that the numbers should be reduced drastically. However, the high pass rate from such a group of under-prepared students might be attributed to the fact that the programme is basically a revision of some easy matric topics and is not targeted. There is also the issue of high staff turn over, as a result the responses from consultations with the staff do not help in the determination of the contributing factors towards good results. More so, the objectives of the programme are not clearly understood by the lecturers.

Students' performance in FMT 1540 for 2007-2010

Headings / Module code	No. Enrolled	No. Wrote exam	No. Fail exam	No. Pass exam	% pass wrote exam
2006					
2007	314	274	61	213	78
2008	136	126	21	105	83
2009	113	104	10	94	90
2010	87	76	4	72	95

Table 1

Students' performance in FMT 1640 for 2007-2010

Headings / Module Code	No. Enrolled	No. Wrote exam	No. Fail exam	No. Pass exam	% pass wrote exam
2006					
2007	247	243	9	234	97
2008	100	86	6	80	93
2009	107	93	6	87	94
2010	85				

Table 2

Foundation students' progress into main stream modules gives us some measure of understanding of how much has been achieved in terms of this intervention strategy.
In light of the above results our position with regard to the SFP at UNIVEN and other universities in the country is that they are different. The situation pertaining to the feeder schools' ability to provide UNIVEN with good students, competition for students with other well resourced institutions, poor language skills and poverty in general justifies for a different approach in defining and minding the gap for UNIVEN. The gap being addressed in other institutions can not fit in the UNIVEN scenario.

The majority of the products of this programme do not end up in the main stream mathematics programmes. For the purposes of this study it is considered that those that register for MAT 1541, 1542, 1641 and 1642 are likely to proceed to the second year or even third year with mathematics as one of the majors. They are the fundamental modules for students majoring in mathematical sciences as well as physical sciences. It is therefore crucial that we investigate the transition phase from high school or SFP into these four first year mathematics modules at UNIVEN.

It must be noted that the enrollment numbers increased significantly between 2008 and 2010. This was due to a decision by the DoE to offer bursaries to mathematics and science teachers who wanted to upgrade their qualifications. They were accepted to the first year university courses in big numbers, albeit without a corresponding increase in teaching staff and other facilities. The staff/student ration had been further reduced. The pass rate steadily declined for MAT 1541 from 80% in 2006 to 64% in 2010. An almost consistent pass rate was maintained for MAT 1542 during the same period. (see Tables 3&4). Out of the enrolled students we have a mix of a number of groups of students: more than once repeating students, straight from matric students and SFP plus first time repeating students. The Foundation and first time repeating students have been lumped together in this study because of the difficulty in obtaining appropriate data and the fact that the repeating students constitute less than 10% of that group, since most of those who would have done badly would have dropped with others having been given an opportunity to supplement. In the next phase of this study this issue may have to be revisited with a view of eliminating repeaters completely. Nevertheless, we believe that the trends were correctly identified with that little discrepancy in our calculations.

Exam performance in FMT 1541 for 2006-2010

Headings / Year	No. Enrolled	No. Wrote exam	No. Fail exam	No. Pass exam	% pass wrote exam
2006	241	192	26	166	86
2007	265	178	50	128	81
2008	182	161	36	125	78
2009	317	275	81	194	71
2010	347	264	94	170	64

Table 3

Exam performance in FMT 1542 for 2006-2010

Headings / Year	No. Enrolled	No. Wrote exam	No. Fail exam	No. Pass exam	% pass wrote exam
2006	196	149	40	109	73
2007	276	217	46	171	81
2008	167	155	39	116	75
2009	311	244	59	185	76
2010	330	269	67	202	75

Table 4

A similar analysis was done on two of our first year fundamental modules, MAT 1641, 1642. We note here the very low pass rate in 2008 MAT 1641 results. The results for the other years are comparable though 2006 had a much higher % pass rate compared to the other years (see Table 5). Performance in MAT 1642 nose dived in 2007 but picked again in 2008 before coming down slightly in 2009 (see Table 6). Two things are worth mentioning here, in terms of the pass rates which are not uniform. Firstly, it is the issue of numbers. The numbers suddenly increased in 2009 without a corresponding increase in resources and as a result we recorded low pass rates in the subsequent years. Secondly, high staff turn over must have played a serious role in all this, in particular in the case of MAT 1541. In trying to establish the depth of the content taught, length and width of the syllabus and caliber of the students from the lecturers concerned one could not come up with consistent answers.

Students' performance in FMT 1641 for 2006-2010

Headings / Year	No. Enrolled	No. Wrote exam	No. Fail exam	No. Pass exam	% pass wrote exam
2006	178	162	25	137	84
2007	167	152	36	116	76
2008	189	162	101	61	38
2009	349	271	86	185	76
2010	419				

Table 5

Students' performance in FMT 1642 for 2006-2010

Headings / Year	No. Enrol	No. Wrote exam	No. Fail exam	No. Pass exam	% pass wrote exam
2006	121	107	31	76	71
2007	204	201	70	131	65
2008	211	184	34	150	82
2009	314	227	52	175	77
2010	339				

Table 6

Most importantly, we compare the results of straight from matric students against those who pass through the SFP. We have decided to only consider first semester modules of mathematics for this analysis. MAT 1541 is Differential Calculus and MAT 1542 is Mathematics Foundations which deals with set theory and other relevant mathematical topics for the development of a student into a proper mathematician or scientist or engineer.

The larger number of students comes from those students who are straight from matric and a smaller number comes from SFP (the number is combined with a very small % of first time repeaters). The year 2008 saw us accepting a large number from SFP compared to the straight students. This could be attributed to old schools curriculum whereby they were less mathematics passes nationally and we had to rely on our Foundation programme for students (see Table 7 below). With the advent of the new schools curriculum combined with DoE students we began to see more straight entries in 2009 as opposed to the Foundation intake. Similar observations were recorded for MAT 1542 (see Table 8 below).

Foundation & Repeat Entry versus Straight Matric Entry -MAT 1541

	Straight Entry	Found + 1st time Rep Entry	% pass exam Straight Entry	% pass exam Found+Rep
2006	107	75	87	81
2007	153	33	69	88
2008	70	79	83	75
2009	212	48	69	67
2010	200	54	67	50

Excluded are students who are repeating more than once. Most of the Foundation students have either joined Life Sciences, Environmental Sciences and Agriculture.

Foundation & Repeat versus straight Matric Entry -MAT 1542

	Straight Entry	Found + 1st time Rep Entry	% pass exam Straight Entry	% pass exam Found+Rep

2006	100	49	70	51
2007	154	59	75	81
2008	70	68	79	71
2009	196	45	73	73
2010				

Excluded are students repeating more than once. Most of the Foundation students have either joined Life Sciences, Environmental Sciences and Agriculture

For MAT 1541 the results show that the straight students do better than the Foundation students except for 2007 where we had a small number of Foundation students. At this stage, it must be noted that it is not all the Foundation students that end up joining main stream mathematics programme. In fact the majority are swallowed by the schools of environmental sciences and agriculture, and some end up doing life sciences in the School of Mathematical and Natural Sciences. In MAT 1542 the trend is similar with straight students doing better than the Foundation ones, though marginally. As might have been expected, the programme does not necessarily prepare students for mathematical and physical sciences and as result the talk about a gap, in the context of other institutions, does not apply. In other words it is just not understood. From this investigation a number of scenarios are implied: The programme is not properly defined and hardly anybody knows how it should be run because there was never a study by UNIVEN itself , other than other studies by scholars from other universities in the country, about its own situation.

The consideration of module throughput rate at UNIVEN may be subjective and as result may not be useful in the study of the gap, since the high module pass rate does not necessarily translate to quality and competency in terms of its products because of some of the reasons mentioned above. The preliminary university audit of 2010 report had no kind words for the university with regard to high module pass rates in a number of cases. Further studies are envisaged in as far as the effect of high staff turnover, lack of targeting of groups at Foundation, minding of the depth of content delivered by different lecturers and many other factors are concerned.

Discussion

After everything that needed to be done has been done and everything that needed to be said has been said, then what remains is to make an analysis of the usefulness of all that. We now know that UNIVEN runs a SFP which is split into two components known as Science Foundation Programmme and Science Enrichment Fondation Programme with the former catering for students whose performance at matric does not qualify them to straight entry into mathematical sciences programmes and the later is meant for those requiring minimum assistance to enter the university.

What comes out clearly, is that the SFPs were never targeted at specific direction of application of mathematics, but rather they were meant to prepare the mathematical underprepared students in meeting the university entry requirements. Just as defined in the SFP students' Hand Book, " *The SFP, which consists of 12 modules, is a foundational provision for a full academic year to facilitate the academic development of students whose prior learning has been adversely affected*

by educational or social inequalities". Clearly, the gap being minded here is different from the gap being discussed elsewhere in other institutions and the two must not be confused.

This study has also laid bare the facts that good pass rates at science foundation must not be understood to mean high level of preparedness for first year university mathematical discourse, but rather it is an improved matric achievement in mathematics as one might put it. Obviously, the improved results might be attributed to reduced adverse factors that were prevalent in schools. The class sizes at foundation are reasonably small and the atmosphere, in general, on campus is more conducive to learning. They also learn language skills required for further development of cognitive skills in the language of instruction. We allude to the fact that even if the ideas are made independent of the language, that in itself does not preclude the need to know the language of instruction very well. We contend that language is important since mathematical thoughts or logical discourses may have to be supported by an instruction delivered and simplified in the language of instruction. As an example students are asked, say, to 'nodimensionalise' an equation given dimensionless parameters expressed in terms of dimensional parameters. These words may scare a potential student who might then think that mathematics was never meant for other people except for those whose first language is English because that student will go out not having understood the instruction and preferring to go to the library to find the true meaning of the terms instead of embarrassing himself/herself by asking the lecturer for an explanation.

The examination results showed that at first year level foundation students lag behind the straight entry students. The one year on campus does not appear to have made significant difference in terms of performance at first year level though it helped them to attain qualification into main stream programmes, more over some of them persevere up to the end of the degree programme whilst others drop out along the way. The high percentage pass rate should not intimidate anyone since the rates are subjective in many ways as indicated earlier on. It has to do with low level content, high staff turn-over and the fact that the entry requirements into the programme is as low as F(SG) in mathematics or science meaning that the content cannot be pitched up as required. It must also be noted that the majority of the students of the two programmes do not end up doing mathematical or physical sciences, but end up in agriculture, environmental science and life sciences where they do not require high level mathematics. It must be noted that even though the programme is resident in the School of Mathematical and Natural Sciences the school ends up absorbing a small percentage of those students. Roughly, the mathamtical sciences and physical sciences get less than a quarter of those students.

From this analysis one is compelled to advise that the school needs to mind two gaps instead of just one, especially with regard to students admission into mathematical and physical sciences. One gap is between sufficiently trained matrics and the underprepared ones, and the other between high school mathematics curriculum and first year university courses. The two gaps cannot be minded simultaneously through the present SFP. Presently, the institution is seen to be minding the first gap, and the school might have to device methods of dealing with the second gap which most institutions in the country are dealing with. In fact that might mean an introduction of the four year degree programmes.

Some might advise for further data collection, at the institution, and further data analysis, but this author believes that all that would be unnecessary exercise because no further convincing is required since it is clear that we simply have to deal with the underlying problems which clearly require fundamental changes.

The most serious effect of the knowledge gap is that students are eventually discouraged from venturing into mathematical and physical sciences because those areas are perceived to be hard. As a result fewer and fewer students opt for sciences and yet everyone is in agreement that we need more mathematicians, scientists and engineers. This calls for a serious intervention by the institution because numbers of students in mathematics are going down rapidly and post graduate training is the worst affected. For a complete report on this topic more studies must be carried out in particular the extent at which outside factors influence our products at the university. More results are envisaged from the second phase of this study.

Conclusion

The most crucial thing for the Mathematics and Applied Mathematics department is to ensure that more students are recruited to join their undergraduate progrmmes so that they would be a bigger pool for postgraduate recruitment. For that to happen the authorities must consider this study seriously and agree to implement some changes in order to bridge the gaps that lead to students deciding to avoid doing mathematics. With a reasonable number of serious post graduate students we would see more and more staff engaging in meaningful research, otherwise the school could end up with a department capable to offer only service mathematics which is obviously undesirable.

Finally, it will not be wrong to advise the institution to move with speed to introduce a four year degree programme to build a bigger pool of students doing mathematics at first year of a four year degree programme. For that project to succeed, a concerted effort could be applied to lure the most disadvantaged but clever students in remote schools who could then be assisted with funding for their education. Those students are then put through a rigorous first year mathematics discourse mixed with modeling and science in their first year of a four year programme to ensure a smooth transition into main stream modules. That would give the Department of Mathematics and Applied Mathematics an opportunity to upgrade students to required level of proficiency in mathematics for its programmes.

It also would be a good practice to set objective and tried entry tests for incoming students followed by proper guidance as to which university programme they must go. It is also recommended that the appropriate English modules at first year level be introduced for those who will have fallen below threshold levels of performance in tests set at the end of the foundation programme or for those coming straight from schools.

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