Performance Determinants in Physical Sciences for ODL Undergraduate Students: The Case of The Open University of Tanzania

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Abstract: *Identifying performance determinants in physical science subjects for students studying through open and distance learning modes in higher learning institutions requires wider range of intuition than it is for conventional institutions. Using data from The Open University of Tanzania, this paper has unearthed some of the core indicators that may explain sufficiently the undergraduate students' performance in physical sciences. The paper has shown that proxy indicators in the past 15 years for both the admission trends and completion rates for students undertaking first degree in mathematics, physics and chemistry are on the decline more than it is for other disciplines in the Faculty of Science, Technology and Environmental Studies. The paper argues that this dismal academic performance is partly aggravated to by the reforms in 2000s to restructure the teaching and assessment systems. The course clusterisation seems to have reduced number of contact hours students had with the study materials and also with other peer groups. The paper also noted relatively higher performance for female students and for relatively older (>30 year old) students. It was also found out that irrespective of lack of necessary education infrastructure in upcountry, students from regions other than Dar es Salaam were performing relatively better than their counterparts from Dar es Salaam. The paper has recommended that the current teaching and assessment systems will only be beneficial to students in physical sciences if they are complemented with occasional face-to-face sessions with subject specialists, with improved study centres and groups based on specialty. Finally frequent on-line dialogue between tutors and students through Moodle platforms or teleconferencing should be the third set of structural reforms that should be undertaken by OUT to revitalize both admission and academic performance of the undergraduate students studying physical sciences at The Open University of Tanzania.*

Key Words: ODL, physical sciences, course clusterisation, assessment system, academic performance

INTRODUCTION

Students' under-achievement in the science subjects has been variously documented (Peng and Wright, 1994; Balogun, 1994). Considering the importance of science and technology, Igwe (1991), asserts that the development of science and technological education is imperative. Therefore, the present situation of students in science education which is deplorable and demoralizing (Ogunniyi, 1986) is no longer tolerable. Perhaps this is what has been a response for many research efforts which have been pre-occupied with identifying factors that could be responsible for this state of affairs with a view to arrest such situation (Mills, 1993; Balogun, 1994; Bajah, 1998). On the other hand, open and distance learning (ODL) is gaining popularity among adults who are keen to upgrade themselves for better career opportunities. Distance learning provides an alternative for people to further their education without having to undergo the traditional classroom learning. Nowadays, not only adults but also youths are becoming interested to pursue higher education in order to compete more effectively in the job market.

In response to this growing interest in higher education, higher learning institutions are creating new courses and using new technologies to meet the demand. Many distance learning on-line courses are developed to meet this increasing need. Many people choose this learning mode of study because of the flexibility and freedom it provides. Some of them enroll in this type of learning courses because they are working full-time and cannot afford to lose their jobs. They need their income for their own as well as their family's living expenses, and leaving their jobs would bring about financial problems. ODL system is a cost-effective way of mass education. On the other hand, especially in the developing countries, students who cannot go to school due to insolvent economic condition of the parents can have education by learning by themselves. ODL systems have proven themselves a way for people to gain education, which would otherwise be not possible (Simonson *et al.,* 2000). They have to find a way to fit learning into their schedule of family and job demands. Some students take up distance learning courses because they live far away from the institutions offering the courses of interest which makes attending classes inconvenient to them (Chute, *et al.,* 1999). Some people have family commitments which make attending classes difficult. These people may have elderly or kids at home to look after and are not able to attend classes. Studying through distance learning can enable them to look after their family while they study. Marcus (2010)[14] points out that there are some people who are keen to do a certain course but feel shy about joining a class. Hence, they choose to do distance learning courses because these courses do not require them to attend classes.

In view of the above benefits, The Open University of Tanzania established the Faculty of Science, Technology and Environmental studies (FSTES) a year after the establishment of the University whereby other (non science) programmes had started. It is likely that the delay in starting science programmes together with other programmes was to give OUT sufficient time to prepare learning materials and related resources for the science students. OUT was actually breaking the widely held belief that mathematics and science courses are difficult and this makes it impossible to study natural sciences through an ODL mode. The failure rates for these courses are alarmingly high not only at conventional face-to-face university levels in Tanzania, but also in lower levels. It took five years since their establishment for OUT to have its first graduate in mathematics. The second batch of graduates in BSc (General) and BSc (with Education) was realised in 2003, seven years after the establishment of the programme where OUT produced 23 graduates (8 in BSc (Gen) and 15 in BSc (With Educ). Of these twenty three, 70% were males and 30% were female graduates. Until 2010 the FSTES has only managed to produce 398 degree graduates equivalent to only 9.3% % of all OUT undergraduate degree graduates. Closer assessment of the science graduates suggests that performance of students in physical sciences (Mathematics, Physics and Chemistry) has been dismal given their nature as compared to other science disciplines like life sciences, home economics as well as BSc ICT (the latter is actually includes enhanced intensive face-to-face lectures). By 2010, there were only 91 degree graduates in physical sciences (equivalent to 22.9% of the FSTES graduates, which is about 0.02% of all OUT graduates).

Many indicators have provided signals that there is a dismal performance in these courses whether taken on their own as BSc (General) or when taken as teaching subjects in BSc (with

[14] http://www.xing.com/net/fernstudium-infos/distance-learning-providers-and-services-305744/distance-learning-what-are-the-benefits-of-distance-learning-27366493/poste posted on 15 Jan 2010, 09:44 am, accessed on 20th June 2011

education). Some of them are such as declining enrolment, declining number of graduates, higher failure rates, etc. In this paper we expect to highlight whether this general perception is valid and also try to find what could explain the (dismal) performance by undergraduate students enrolled in physical sciences. The objectives of this paper are three fold; firstly we review the trends in admission and academic performance of undergraduate students at OUT with a focus in physical sciences. Secondly, we assess whether or not the various changes OUT has undertaken in the learning and assessment systems have affected performance of undergraduate students in physical sciences. The third objective of this paper is assessing whether demographic profile of OUT students taking physical sciences has any influence on academic performance. We use data for continuing students and graduates in physical sciences in BSc (Gen) and BSc (Educ) from1995 to-date to substantiate the various indicators of academic performance. Where possible, measures of central tendency will be used in the comparison between performance in physical sciences and other science disciplines in order to provide informed arguments for the performance differentials.

This paper is divided into four main sections. We start by introduction followed by an overview of the science teaching, admission and graduation trends at OUT. In the third section we review the reforms that OUT has undertaken in the teaching and assessment procedures since 1995 and link them with the performance of students in physical sciences.

Table 1: Admission Trend Showing Percentage of Physical Sciences Vs Other Science Disciplines in the FSTES 1995-2010

Year	Physical Sciences		Faculty Total		University total (N)
	N	Faculty (%)	N	University (%)	
1995	50	53.8	93	12.6	738
1996	68	41.7	163	14.8	1101
1997	64	55.2	116	15.4	755
1998	57	38.0	150	20.1	747
1999	24	21.6	111	17.9	619
2000	17	9.7	176	26.1	675
2001	33	13.9	237	19.6	1209
2002	20	9.3	214	16	1340
2003	16	7.8	205	13.1	1567
2004	41	14.5	283	14.7	1920
2005	18	5.9	305	11.3	2692
2006	19	4.6	409	11.8	3460
2007	90	9.7	925	16.3	5668
2008	24	6.0	401	15.6	2565
2009	15	3.1	485	13.8	3506
2010	41	15.7	261	11.7	2234
Total	**547**	**12.0**	**4544**	**14.4**	**31569**

Source: **Admission Office (2005-2010); OUT Facts and Figures (2010)**

We turn to assessment of demographic profile of graduates in physical sciences in the fourth section and link them with the graduates' academic performance. The last section will be the overall conclusion and our recommendations to improve and sustain teaching of the physical science subjects through ODL.

OVERVIEW OF THE SCIENCE TEACHING AT OUT

The Faculty of Science and Environmental Studies (FSTES) was established in 1995, a year after OUT's inception. This Faculty started with two programmes: BSc (General) and BSc (with Education). The subjects that the faculty has been offering include life sciences (biology, zoology and botany), home economics and physical sciences (mathematics, physics and chemistry). Later on, there were other two programmes introduced in the Faculty: BSc ICT (in 2006) and BSc Environmental Studies (in 2008). Whereas BSc ICT is conducted through enhanced face-to-face sessions, other programmes are conducted through purely ODL modes.

Admission Trend Showing Percentage of Physical Sciences vis other Science Disciplines in the FSTES (1995-2010)

It can be observed from Table 1 that the trend in admission of students in physical sciences has being declined when compared to other disciplines at the University over years. Within the faculty, generally the admission into life sciences has been increasing and is the most impressive of all disciplines in the FSTES.

The graphical presentation in Figure 1 shows that that the admission into physical sciences was highest in 2007 but thereafter started to decline. This year was due to Government introduction of special programme (Licensed Teacher). The declining trend could have been a result of course clusterisation, which made courses too voluminous to handle by students in physical sciences.

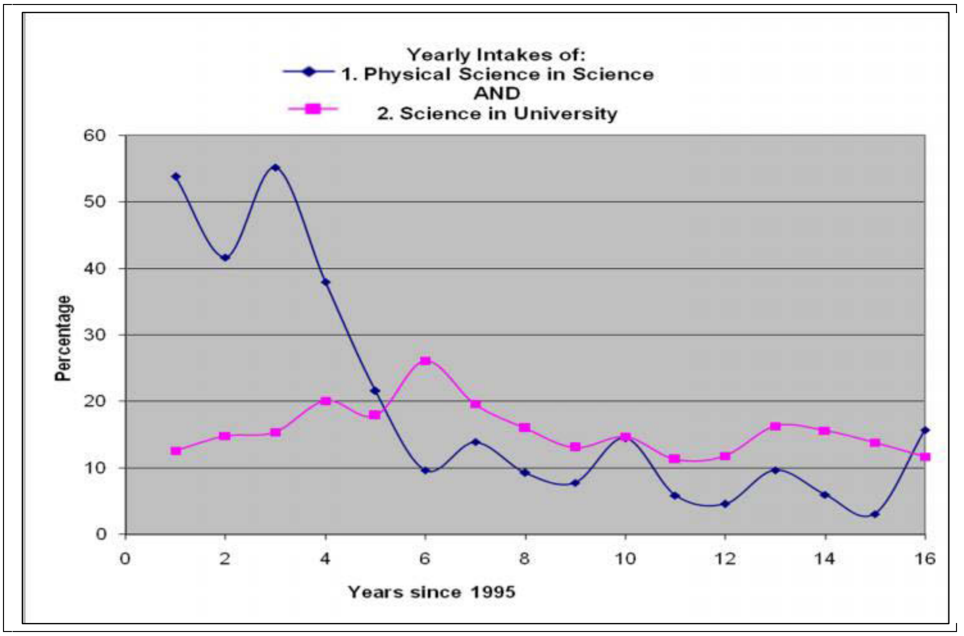


Fig 1: Admission Trend in Yearly Intakes in Percentages of Physical Sciences in Science and Science Students in University (1995-2010). ***Data Source:*** **Table 1**

Graduation Trend in Physical Sciences Vs Other Disciplines in FSTES Undergraduate Programmes 1995-2010

The first graduate of the Faculty of Science Technology and Environmental Studies was a mathematics student. The student was enrolled in 1995 in BSc (Double Mathematics) and graduated in 2000 with a Second Class (Honours)-Upper Division degree. The Faculty had its next graduates in 2003 where majority were graduates in life sciences (Table 2). We can also observe from Table 2 that majority of graduates were those who took BSc with education.

Table 2: Graduation Trend in Physical Sciences versus Other Disciplines in FSTES Undergraduate Programmes 1995-2010

Year	Physical Sciences		Life Sciences		Home Econ &Human Nutrition		BC ICT		Faculty Total		University Total (N)
	N	Faculty (%)	N	Faculty (%)	N	Faculty (%)	N	Faculty (%)	N	University (%)	
2000	1	100	0	-		0.0		0.0	1	5.9	17
2001	0	0.0	0	-	0	0.0	0	0.0	0	0.0	82
2002	0	0.0	0	-	0	0.0	0	0.0	0	0.0	87
2003	8	34.8	15	65.2		0.0	0	0.0	23	10.8	213
2004	8	25.0	22	68.8	2	6.3	0	0.0	32	11.9	270
2005	9	30.0	18	60.0	3	10.0	0	0.0	30	7.2	418
2006	6	20.7	21	72.4	2	6.9	0	0.0	29	9.8	296
2007	9	17.6	35	68.6	7	13.7	0	0.0	51	9.6	530
2008	7	12.5	26	46.4	13	23.2	10	17.9	56	12.1	462
2009	20	29.0	33	47.8	10	14.5	6	8.7	69	7.0	980
2010	23	21.5	52	48.6	17	15.9	15	14.0	107	11.4	941
Total	**91**	**22.9**	**222**	**55.8**	**54**	**13.6**	**31**	**7.8**	**398**	**9.3**	**4296**

Source: **Facts and Figures (2010), Directorate of Examination Syndicate (various reports 2008-2011) and OUT Graduation Booklets (2000-2010)**

Table 2 shows that overall the FSTES has contributed only 9.3% of graduates University-wide. The proportion of the number of graduates in physical sciences compared to University admission is insignificant (0.02%). Graduates in physical sciences have constituted only 22.9% of the Faculty graduates since 2000 when the Faculty had its first graduate to 2001. This observation is qualified by the declining trend in proportion of physical sciences graduates in overall FSTES total graduates indicated in Figure 2. However from 2009 the nominal number of graduates in physical sciences has improved with 23 graduates in physical sciences graduates in 2010, the highest figure so far attained in one year.

It can be noted that both the admission and graduation rates for FSTES are on the declining trend for the undergraduate programmes in the Faculty. However, the physical sciences are the most affected of all disciplines in the Faculty as it happens to have sharper downward.

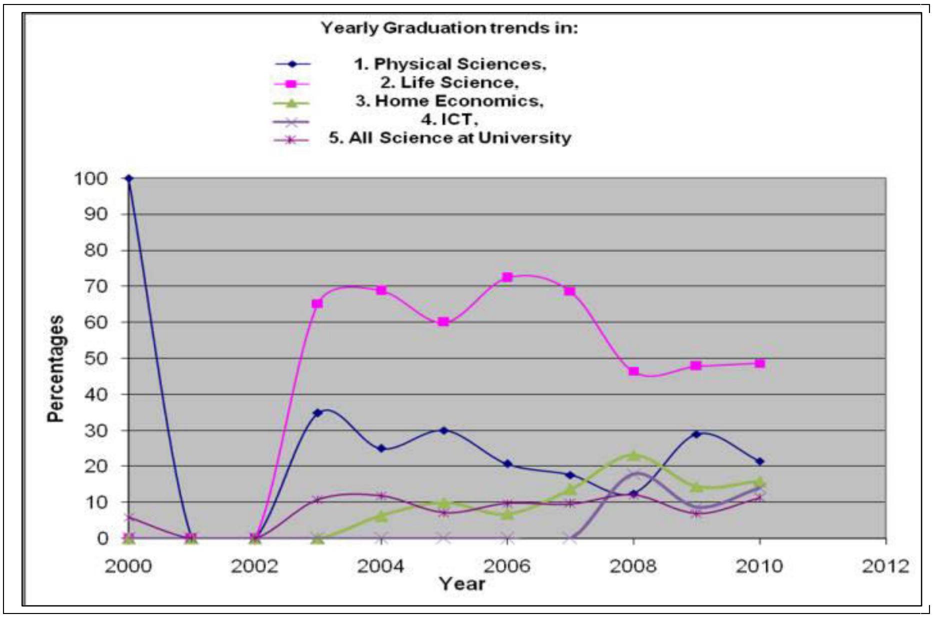


Figure 2: Graduation Trends (in %) in Various Science Disciplines 1995-2010

Data Source: **Table 2**

REFORMS IN TEACHING AND ASSESSMENT SYSTEMS AT OUT AND THEIR IMPACT ON PERFORMANCE OF STUDENTS IN PHYSICAL SCIENCES

Like many other higher learning ODL institutions, The Open University of Tanzania (OUT) right from the beginning realized the importance of reformation as has been using formative assessment in order to support student learning. Between 1994 and 2009, OUT used four main formative assessment tools to evaluate its students, namely; two take-home assignments, two timed-tests, two face-to-face sessions and yearly practicals and at least one fieldwork session. It was however realized that the formative system was time consuming for both students and tutors and was costly. In order to address the constraint, effective from 2009/2010, the formative assessment at OUT was changed to comprise only one test, yearly practicals, one field practice, and one extended face-t- face sessions. The test is marked before the face-to-face sessions. Assignments have been abolished because of the tendency by some students to copy from each other and also pay agents to assist them. Instead the Student Progress Portfolio (SPP) has been introduced. The SPP is meant to assess student's preparedness to sit for main test and end of year examinations.

In their most recent paper, Bisanda *et al.* (2011) outline various assessment reforms that OUT has undertaken to, among other things, improve the teaching, learning and assessment modalities at OUT. In their paper they have indicated that the reforms have actually increased numbers of graduates not only in terms of numbers but also in completion rate of undergraduate studies. Based on 2009 and 2010 graduation data, the authors point out that the number of graduates completing in 3 years has increased from merely 5% to 31% in 2009 and 2010 respectively. They link this achievement to the reforms undertaken by OUT in 2008 whereby all the coursework components for each course were replaced by only one timed paper and compulsory Students Progress Portfolio. Bisanda *et al.* (2011) did not look into whether there was a variation in impact of the reforms on the various degree programmes. In this section we review the reforms with more focus to their impact on academic performance for students undertaking physical sciences.

With ODL mode, the study material is prepared in a way to represent a tutor in a conventional fac- to-face. The study materials that the FTSES started with in 1995 and which were later on reviewed and more written had a weight of single unit for each. Each study material comprising of about ten lectures was taken as an independent course. Thus an OUT student to complete one two-unit course (equivalent to one studied at the conventional university in one academic year) had to study two one-unit courses in two years, one each year. For each study material, there were four formative assessment items (two assignments and two timed tests) and one annual examination. In addition, a student was supposed to undertake yearly residential lab practicals and one field experiment. Hence it would take six years for the OUT student to graduate in a similar course that takes a student to graduate in three years at the conventional university. However, due to reasons explained in Bisanda *et al.* (2011) such as having backlog of unmarked scripts and overloading students with many take home assignments and tests, the Faculty of Science undertook course clusterisation in 2006/2007 where single unit courses were abolished and two to three single courses were clustered to form one two/three-unit course. The total number of courses in mathematics, physics and chemistry for example decreased to 48 from 96 courses that were in place before 2007. Many believe that this paradigm change is one of the influences towards dismal performance in physical sciences. The other major changes which took place with effect from 2008 to reduce formative assessments per course are believed as having doubled the problem already introduced by course clusterisation.

Table 3: Completion rate for 2000-2006 and 2007-2010 graduation for undergrads in Physical sciences[15]

Number of Years to graduate (Y)	2000-2006			2007-2010		
	Number of graduates (N)	%	YiNi	Number of graduates (N)	%	YiNi
3	1	2.8	3	6	10.5	18
4	3	8.3	12	5	8.8	20
5	5	13.9	25	15	26.3	75
6	7	19.4	42	10	17.5	60
7	7	19.4	49	3	5.3	21
8	5	13.9	40	5	8.8	40
9	7	19.4	63	3	5.3	27
10	0	0.0	0	8	0.0	80
11	0	0.0	0	0	0.0	0
12	0	0.0	0	0	0.0	0
13	1	2.8	13	2	3.5	26
Total	**36**	**100**	**247**	**57**	**100**	**367**
AVERAGE COMPLETION RATE	**6.9 YEARS**			**6.4 YEARS**		

Data source: **OUT graduation booklets (2000-2010), DES data (2011*)***

[15] We use Bisanda *et al.* (2011) formula where graduation rate R is computed as $R = \frac{\sum YiNi}{\sum Ni}$ where Y is the number of Study Years and N is the number of graduates completing studies within the same period.

Completion rate for 2000-2006 and 2007-2011 graduation for undergrads in Physical sciences

The completion rate for graduates in physical sciences in the two periods, 2000-2006 (prior to course clusterisation) and 2007-2010 (after clusterisation and new assessment system) suggests that the two changes have had positive impact on completion rate for students in physical sciences in terms of turn outs. It can be observed from Table 3 that majority of graduates in physical sciences completed their studies in less time after the reforms period. Table 3 shows that graduates in physical sciences completing within 3 years have increased from 2.8% before reforms to 10.5% after reforms. In addition, the number of students completing in over five years has decreased from 74.8% to 54.4% before and after reforms respectively.

An interview with OUT physical science students of various demographic backgrounds gave mixed feelings on the impact of the reforms on the completion rate of their studies. A fifth year student studying BSc (mathematics and physics) and who seemed to be in his late 40s had this to respond to this inquiry:

> "It's very hard now than before. In the past we had chances of having intensive reading because assignments were forcing us to work hard unknowingly. There were also intensive face-to-face sessions with subject matter specialists at least twice a year during which we had opportunities to ask questions. All these opportunities are gone now. The courses are now very huge to master and you have to study two to three different books before you sit for the test or exam. It demands more face-to-face sessions now than before. The University should rethink helping us who are studying these most feared subjects..."

Another interview was done with a student in her mid 30s who has completed studies and awaits to graduate in BSc in mathematics and chemistry (with Education). Although she was in favour of the teaching and assessment reforms, she had some reserved observation:

> "…The current assessment is very appropriate for those who are fresh from A levels and also for students in other disciplines in the Faculty of Science irrespective of their academic background, but certainly not for physical sciences. After assignments were removed our study centres/groups were dissolved, everyone had to seek own tuition classes than before, this was very expensive. When we had assignments to do, were meeting with other students to discuss on lecture activities indicated in the study materials and we would thereafter assist each other to answer assignments. There was nothing forcing us to meet any more. The assignments were bringing us together. Unfortunately it is hard to learn subjects in physical sciences in isolation, one needs to exchange concepts with others- this habit is gone and it is likely going to affect many students in the pipeline. OUT should expect many students especially in the physical sciences stream to change to programmes which are mostly favoured by the new assessment system like BBA or LLB..."

One of the most experienced academic staff in the FSTES was in support of the arguments posed by the critics of the new assessment when he noted that since 2009, the Faculty has attracted fewer and fewer students opting for physical sciences and that many more were changing programmes from BSc (in physical sciences) to others like BBA. However, the academic staff was still sceptical as to whether the changes in assessment system were solely responsible for this paradigm decline in willingness for students to opt for physical sciences. To him this paradigm shift was not a national issue but a global concern as well.

Impact of Assessment Reforms on GPAs of Graduates in Physical Sciences

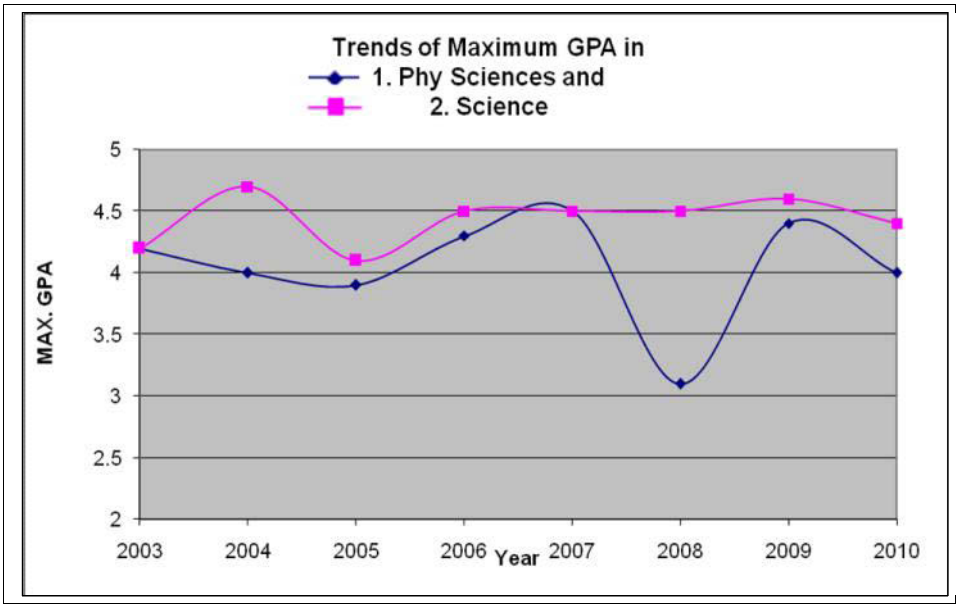
Relatively, the mean GPAs for graduates in physical sciences have been consistently lower than in most programmes in the Faculty of Science (Table 4). This implies that students pursuing physical sciences graduate with lower grades than those doing other disciplines. The average minimum GPAs for physical sciences were higher in both before and after reforms but the average maximum GPAs in physical sciences were relatively lower in both periods. Table 4 shows that although there has been a decline in GPAs after reforms for both graduates in physical sciences and for the whole faculty as a whole, the effect seems to be more influential to physical science graduates.

Table 4: Graduates' GPAs in Physical Sciences vis Faculty and University Statistics: 2003-2010

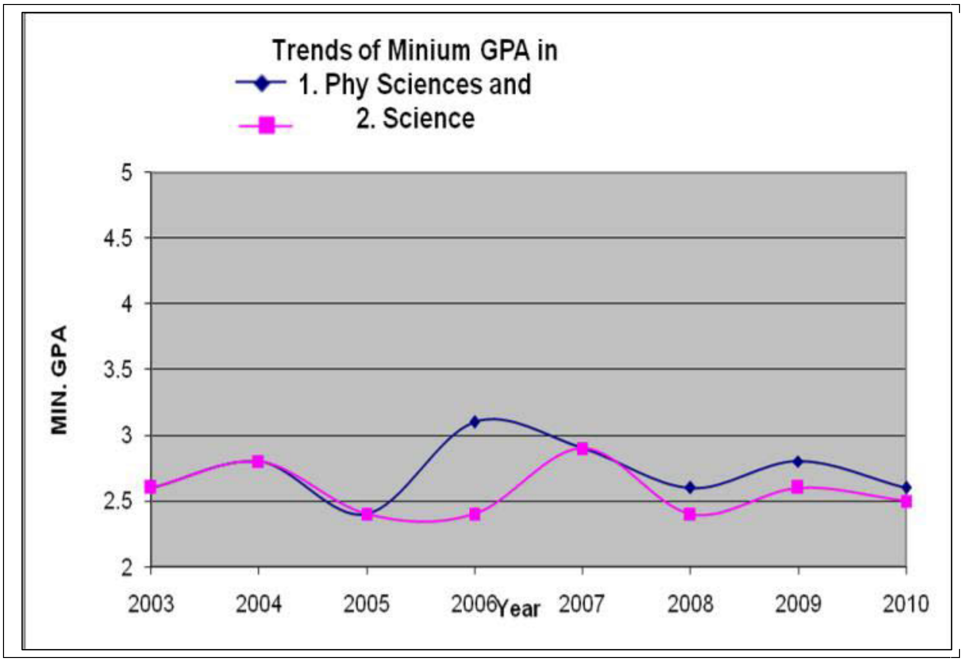
Year	Category	GPA		
		Minimum	Maximum	Mean
2003	FSTES	2.6	4.2	3.6
	Physical Sciences	2.6	4.2	3.5
2004	FSTES	2.8	4.7	4.4
	Physical Sciences	2.8	4.0	3.3
2005	FSTES	2.4	4.1	3.0
	Physical Sciences	2.4	3.9	3.2
2006	FSTES	2.4	4.5	3.2
	Physical Sciences	3.1	4.3	3.5
2007	FSTES	2.9	4.5	3.5
	Physical Sciences	2.9	4.5	3.3
2008	FSTES	2.4	4.4	3.4
	Physical Sciences	2.6	3.1	2.9
2009	FSTES	2.6	4.6	3.3
	Physical Sciences	2.8	4.4	3.4
2010	FSTES	2.5	4.4	3.2
	Physical Sciences	2.6	4.0	3.4
2003-2007	FSTES	2.55	4.38	3.55
	Physical Sciences	2.73	4.10	3.38
2008-2010	FSTES	2.60	4.48	3.35
	Physical Sciences	2.73	4.00	3.25

Data Source: **OUT graduation booklets (2004-2010), DES databases (2008-2010)**

Figure 3 shows that the GPAs for graduates in physical sciences have been decreasing suggesting that the clusterisation and reforms in assessment system could have negatively affected scores obtained by students in physical sciences.



Figures 3(a): Maximum GPAs for graduates in Physical Sciences and FSTES: 2004-2010



Figures 3(b): Minimum GPAs for graduates in Physical Sciences and FSTES: 2004-2010

Data Source: **Table 4**

Performance in annual examination scores for physical science students: 1995-2010

Table 5: Performance in annual examination scores for physical science students: 1995-2010

Year	Mathematics (%)	Physics (%)	Chemistry (%)	Overall (%)
1995-2000	52.3	49.3	45.8	**49.1**
2001-2005	50.6	39.5	55.3	**48.5**
2006-2008	52.8	48.6	35.3	**45.6**
2009-2011	43.0	46.9	48.7	**46.2**
Overall (%)	**49.7**	**46.1**	**46.3**	**47.3**

Data Source: **DES database (various reports)**

Table 5 suggests that there were higher scores in physical sciences prior to the introduction of the mid 2000s reforms in teaching and assessment. Figure 4 illustrates the declining trend of scores (for mathematics and physics) implying that clusterisation and changes in assessment system have had negative impact in performance in terms of numerical grades.

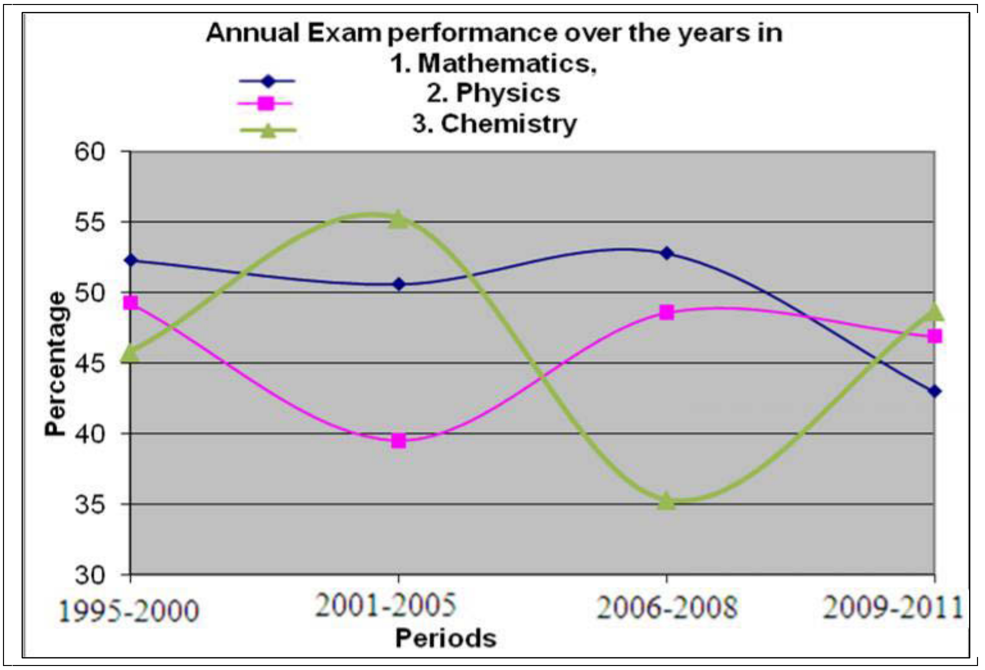


Figure 4: Performance in annual examination scores for physical science students: 1995-2011

Data source: **Table 5**

IMPACT OF DEMOGRAPHIC PROFILE OF STUDENTS IN PHYSICAL SCIENCES ON THEIR ACADEMIC PERFORMANCE

Table 6: Relationship between selected demographic profile of students and scores in annual examinations[16]

Year/Profile	Average score (%)					
	Sex*		Home region**		Age (years)**	
	Female	Male	Dar	Others	<30	>30
2003	50.8	43.7	49.4	51.7	48.1	61.2
2004	37.8	31.7	45.5	49.9	53.2	55.9
2005	37.5	34.6	36.8	41.7	39.6	44.2
2006	26.8	15.2	31.3	33.6	50.3	51.1
2003-2006	**38.2**	**31.3**	**40.8**	**44.2**	**47.8**	**53.1**
2007	35.7	35.5	39.3	39.6	42.9	51.1
2008	49.3	49.8	50.2	54.9	40.4	41.3
2009	23.8	25.3	24.6	30.5	31.9	47.7
2010	34.5	31	35.9	34.8	35.8	51.4
2011	33.8	22	34.4	43.6	33.3	49.7
2007-2011	**35.4**	**32.7**	**36.9**	**40.7**	**36.9**	**48.2**

* Examination results database (various years)
** Prospective graduands in October 2011
***Source:* DES database (various years)**

Table 6 indicates on average, females studying physical sciences perform better than male counterparts in terms of their scores in annual examinations (Figure 5a)

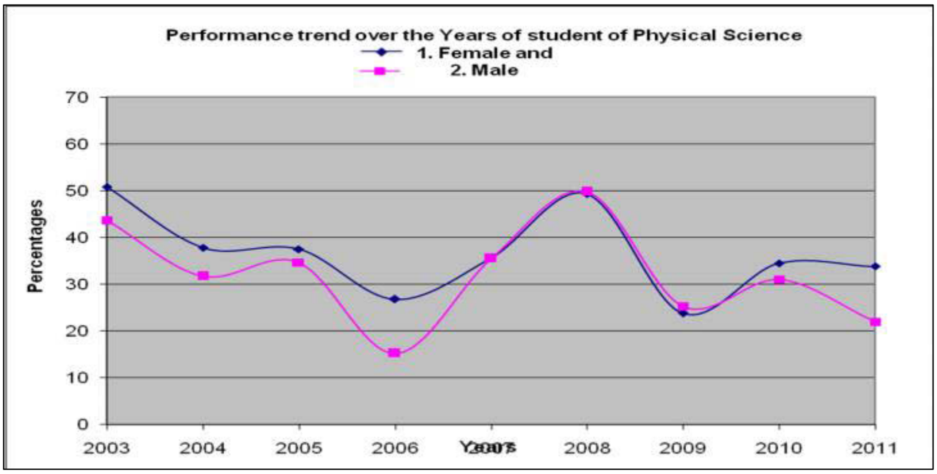


Figure 5 (a): Relationship between Gender and scores in annual examinations *Data Source:* Table 6

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[16] We compute average of the annual examination scores for only three basic level 1 courses. For each year a score sample of 10 students were randomly picked

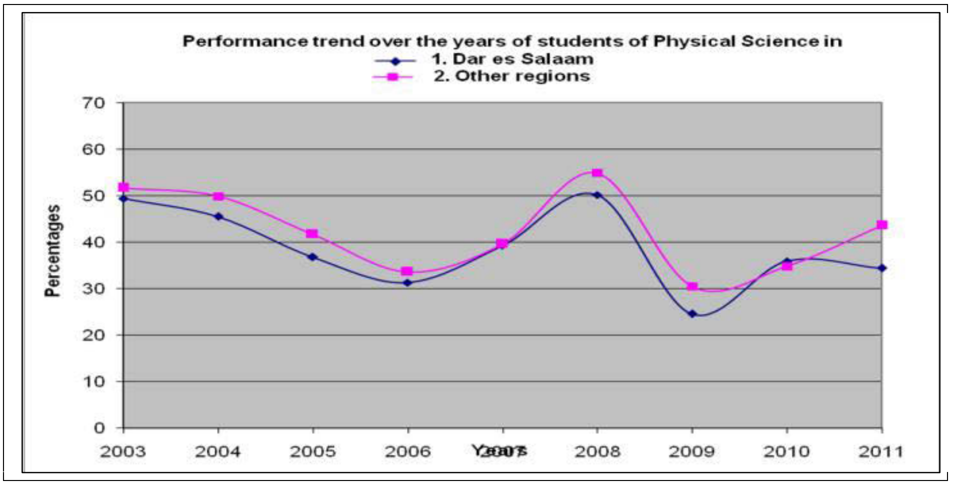

Figure 5(b): Relationship Between Home Regions and Scores in Annual Examinations[17]
***Data Source:* Table 6**

Irrespective of the fact that there are many supporting services from students in Dar es Salaam, their performance seems to be lower than scores by those coming from the regional centres (Figure 5b). Likewise, young graduates score slightly lower marks than the older ones (Figure 6). Most young students are likely unemployed hence their direct application or use of the gained knowledge is limited and this could explain why experienced students (teachers and probably older students) perform relatively better than others.

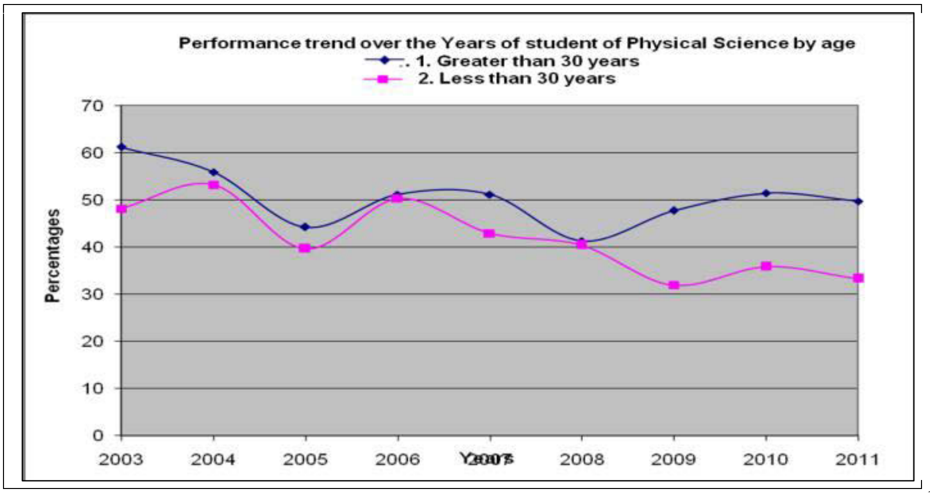

Figure 6: Relationship Between Age of Students and Scores in Annual Examinations[18]
Data Source: Table 6

[17] We compute average of the annual examination scores for only three basic level 1 courses. For each year a score sample of 10 students were randomly picked

[18] We compute average of the annual examination scores for only three basic level 1 courses. For each year a score sample of 10 students were randomly picked

CONCLUSION

Throughout the paper we have demonstrated a few signals that suggest that apart from other factors that affect ODL students as a whole, course clusterisation and reduction of formative assessment have affected their academic performance in terms of numerical grades in specific subjects. The course clusterisation has resulted to declining contact hours for the clustered courses whereas removal of take home assignments and timed tests have reduced intensity of revisions that students make before they sit for the final exams. We show that the overall performance of students before 2007 (before clusterisation) was relatively better than performance after 2007 (after clusterisation). However, we have also shown that the graduation rate in terms of number of graduates seems to have increased after 2007 implying that reforms have increased completion rate. The number of graduates completing within three years has risen from 2.8% before reforms to 10.5% after reforms. We note that although the completion rate has risen after reforms, the graduating students have lower GPAs than those who completed prior to the reforms. Based on these findings we recommend the following policy issues that may be considered by OUT in improving both the learning environment, increased number of graduates and above all producing graduates in physical sciences with better grades and GPAs:

- To complement the reforms with more enhanced face-to-face sessions. The use of e-learning platforms should be made more user friendly for easy interactions between lecturers and students.

- There is need for OUT to design degree programmes from physical science subjects as they are thought not to be directly attractive to most employers in the country if they are studies as basic science subjects. Professionalism in these courses will attract more qualified applicants into such programmes e.g. BSc Microelectronics, BSc Measures and Weights etc.

- OUT should closely collaborate with the existing applied physical science-supporting infrastructure such as laboratories in higher learning institutions, vocational training etc. whereby students will have easy access to such infrastructure. It has so far worked well with such agreements with access to libraries.

- The Government introduced licensed teacher programme in 1997, the highest peak of admission in physical science subjects was observed by OUT (Table 1). However funds were not availed in the subsequent years and the programme is currently not operational. The programme was found to be very suitable to physical sciences students because it had a four weeks residential intensive face-to-face lecture session twice a year. The licensed teacher graduates are now in the teaching industry. In order to reduce the deficit of science teachers in Tanzania we recommend that such programmes should be continuous until such time when there will be sufficient teachers in physical sciences particularly in secondary schools.

References

Bajah, S. T. (1998). Stepping into science: The ELSSA way. *STAN Bulletin*, **15(2),** 6 – 7.

Balogun, T. A. (1994). Gender issues in the teaching of science, technology and mathematics. In S. Y. Erinosho (Ed.) *Perspectives on Women in Science and Technology in Nigeria*, Ibadan: Sam Bookman Educational & Communication Services, 46 – 61.

Chute, A., Thompson, M., and Hancock, B. (1999). *The McGraw-Hill handbook of distance learning.* New York: McGraw-Hill.

Entwisle, D. (1986). The schooling process in first grade: Two sample a decade apart. *American Educational Research Journal* **23**, 587 – 613.

Igwe, G. O. (1991) Impact of behaviour objectives, cognitive entry behaviour and locus of control paradigm on students' learning outcomes. Ph.D. Thesis, University of Ibadan, Nigeria.

Keeves, J. P. (1992). *Learning science in the changing world: Cross-national studies of science achievement 1970 – 1984*. 52 – 56. IEA International Headquarters, Australia,

Mills, A. (1993). Gender differences in academically young students in mathematical reasoning patterns across age and sub-skills. *Journal of Education Psychology* **2,** 340 – 346.

Ogunniyi, M. B. (1986). Two decades of sciences education in Africa. *Science Education*, **70(2),** 111 – 122.

Peng, S. S. and Wright, D. (1994). Explanation of academic achievement of Asian – American students. *Journal of Educational Research*, **87(6),** 346 – 382.

Simonson, M., Smaldino, S., Albright, M., and Zvacek, S. (2000). *Teaching and learning at a distance: Foundations of distance education.* Upper Saddle River, NJ: Merrill (Prentice – Hall).