Proceedings of the Technical Sessions, 21 (2005) 35-47
Institute of Physics – Sri Lanka

Presidential Address (2005)

Producing Science Graduates: Are we on the right path?

D.U.J. Sonnadara
Department of Physics, University of Colombo, Sri Lanka

University statistics related to enrolment and producing graduates are presented. In science streams the Sinhalese enjoy 10% more than their share of the university enrolments. Time trends show that there is a steady decline in Tamil enrolment and an increase in Muslim and other ethnic group enrolments over the last decade. The unit recurrent cost of producing graduates is high at the new universities and they do not contribute very much to graduate output. By improving the internal efficiency of the system with the already existing resources, graduate output can be increased substantially. Across the universities, funding has not been consistent and not tied to performance. On average 14% of the students enrolled in universities come from poor income households.

1. INTRODUCTION

The responsibility of primary and secondary education in Sri Lanka is virtually handled by the public sector which accounts for about 93% of schools and 95% of student enrolment. Students follow the national curriculum and sit for national examinations. This is a direct result of the policy that forbids the setting up of private schools in Sri Lanka, which was implemented in the 1960s [1]. In recent years, due to heavy public demand, a growing number of international schools have been setup by the private sector especially in the main cities, which prepare students for foreign examinations.

Net enrolment figures show that, nearly all students complete up to grade 5. Although the compulsory education cycle extends up to grade 9, the net completion rates drop to about 81% for boys and 84% for girls [1]. This is in spite of providing tuition free schooling, free text books, free uniforms and subsidized transport etc. Thus, 18% of the students fail to complete the compulsory education cycle and the evidence suggests that they are drawn from poorer households.

The performance of students at the two main national examinations G.C.E. O/L and G.C.E. A/L is far from satisfactory. The average pass rate at the G.C.E. O/L examination is roughly 40% [1]. In general, higher percentages of pass rates have been observed in richer provinces (such as Western) compared to the poor provinces (such as Uva). Time trends show that over the last decade, there is a steady improvement in the average G.C.E. O/L pass rates (nearly 2% increase per year). The G.C.E. A/L pass rates average about 56% for the country and it does not show any dependency on the province [1]. Unlike the G.C.E. O/L, the G.C.E. A/L pass rates have been constant over

the last 10 years. These students represent the best in their age groups and deserve none other than the best education that can be provided by the system.

The total tertiary education enrolment is about 11% which is comparable to the South Asia average of 10% [1]. This consists of university enrolment of 3%, advanced technical education enrolment of 2% and private tertiary education enrolment of 5%. Private degree awarding institutes contribute to about 20% of the total university enrolments. The share of private sector participation in advanced technical education is quite high (roughly 50%). Thus, the private sector dominates enrolment at the tertiary level.

Presently there are 12 public universities offering internal degrees to the students who qualify at the GCE A/L examinations. Although about 90,000 pass the A/L examinations and qualify to follow degree programs, all universities taken together admit about 13,000 graduates per year [2]. This is only 14% of those who qualify to follow a degree program. The percentage varies between the subject streams, the Physical Sciences rank the highest (38%) followed by the Biological Sciences (28%), Commerce streams (10%) and Arts streams (9%). As far as the science streams are concerned, the total intake is about 2650 among 11 universities. This constitutes of the 6 oldest universities, Colombo, Peradeniya, Sri Jayewardenepura, Kelaniya, Jaffna and Ruhuna catering to roughly 81% of the total number of students. From the remaining 5 universities, Rajarata, Sabaragamuwa and Wayamba cater to roughly 15% and the remaining two universities, Eastern and South Eastern presently cater to only 4% of the students.

The main focus of this paper is to present the statistics available on university enrolment and other related indicators especially relating to the science streams and to see whether the public universities are on the right path with respect to producing science graduates. Several key problems have been identified and presented for the benefit of the decision makers.

2. UNIVERSITY STATISTICS

2.1 Gender preference

Engineering and related disciplines have the highest percentage of male students (85%) followed by the Physical and Biological Sciences (60%). The lowest percentage is in Performing Arts and Law (25%) followed by the Social Sciences (34%). Although the ratio of male to female participation various between the years, time trend data show that there is a clear trend of increasing female participation (about 1% per year) in the engineering as well as science streams. However, in the medical streams, female participation has been quite steady and remained just below 50% over the years. The time trends of female participation for the above three disciplines are shown in Figure 1.

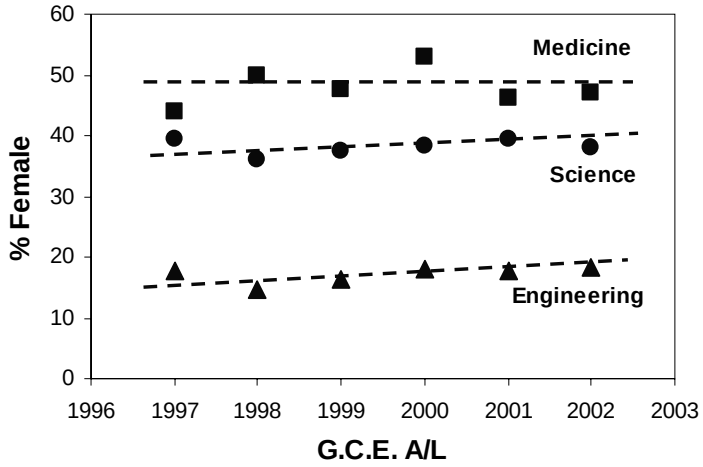

Figure 1: Time trend of female participation for the engineering, science and medical streams (1997 - 2002).

2.2 Ethnic composition

Contrary to popular belief, the 2002 enrolment data indicate that Sinhalese enjoy 8% and 10% more than their share for Physical (82%) and Biological Science (85%) enrolments respectively compared to other ethnic communities. Tamils have 4% and 8% less than their share for the same. This is assuming the population ratios are at 74% Sinhalese, 18% Tamils and 8% Muslims and other communities. The time trend of ethnic composition shows that over the years there is a steady decline in Tamils and a steady increase in Muslims and other communities. In fact, just a few years back, in 1999, the participation of Tamils in the Physical Sciences was 18% which is the correct share for their community (see Figure 2). The reason for this decline is not known although one may suspect effects due to the ethnic conflicts.

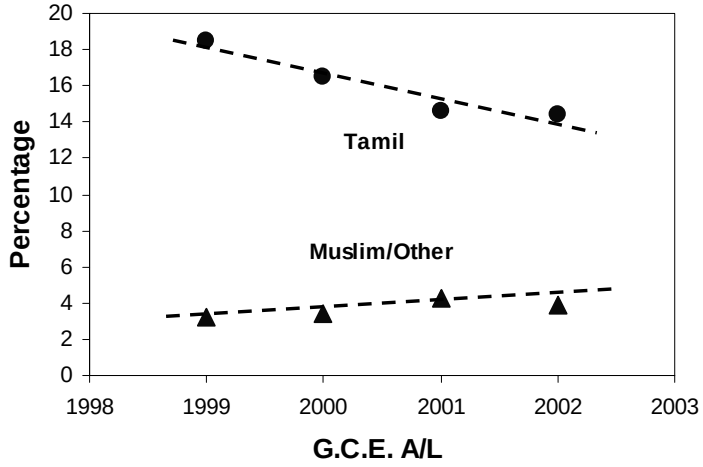

Figure 2: Time trend of Tamil, and Muslim and other enrolments in the Physical Science stream (1999 - 2002).

2.3 Student preference

UGC published data show that Colombo is the number one university for student preference in science [3]. The quality of students entering the universities can be measured by their average Z-scores. The 2003/2004 data show that Colombo attracts the best students for the sciences (see Table 1). This is followed by Peradeniya, Kelaniya and Sri Jayewardenepura having similar Z-scores. Ruhuna and Jaffna come next. In general, the Biological Sciences show higher Z-scores than the Physical Sciences except for Jaffna. It is not clear whether this difference is due to competition or due to the difference in the nature of the subjects within the disciplines.

Table 1: Quality of students entering universities (2003/2004 statistics).

University	Physical Sciences		Biological Sciences	
	Intake	Z-score	Intake	Z-score
Colombo	240	1.7283	125	1.8978
Peradeniya	250	1.4307	100	1.6015
Kelaniya	245	1.3834	165	1.6074
Sri J'Pura	170	1.3910	80	1.5850
Ruhuna	210	1.2401	130	1.4499
Jaffna	250	1.2549	100	1.1474

2.4 Students on roll and graduate output

The students on roll in the science streams show that the 6 oldest universities (Colombo, Peradeniya, Kelaniya, Sri Jayewardenepura, Ruhuna and Jaffna) established between 1942 and 1978 handle 84% of the total number of students at any given time (see Table 2). The Eastern University, which was established in 1981 handles only 2% of the students. This is quite unsatisfactory considering the fact that the university has been in operation for the last 21 years (up to 2002). The South Eastern and Rajarata universities which were established in 1995 each handle only 2% whereas Sabaragamuwa and Wayamba which were established between 1995 and 1999 each handle 4% of the students. The higher percentages of students on roll in the older universities also reflect the strength of the 4-year specialized degree programs offered by them. Universities such as Colombo offer 4-year specialized degree programs to nearly 50% of the students who are in the science streams and thus handle 18% (nearly 1/5) of the total students on roll in the science streams.

The reader is cautioned about the accuracy of the numbers given in Table 2 (especially related to the smaller universities) due to possible errors in published data and difficulty in estimating due to the fluctuations of student enrolment between the years.

Table 2: Students on roll and graduate output in the sciences (2002).

University	Year of Establishment	Years in operation	Students on roll	% Share on roll	Graduate Output	% Output
Colombo	1942	60	1452	18	287	80
Peradeniya	1942	60	1314	17	227	56
Sri J'Pura	1959	43	806	10	144	47
Kelaniya	1959	43	1167	15	177	43
Jaffna	1974	28	744	9	139	59
Ruhuna	1978	24	1171	15	176	45
Eastern	1981	21	190	2	47	64
S. Eastern	1995	07	161	2	*12	*22
Rajarata	1995	07	185	2	*23	*37
Sabaragamuwa	1995	07	356	4	*36	*30
Wayamba	1999	03	342	4	*27	*24

The graduate output shows that all universities perform quite poorly and have room for improvement (see Table 2). To avoid statistical fluctuations, graduate output has been calculated by taking the average of several years of data. The data has also been corrected for the effect of taking double batches to clear the backlog. The University of Colombo show 80% success. Universities such as Sri Jayewardenepura, Kelaniya and Ruhuna show percentages below 50% which is quite unsatisfactory. For the small universities (indicated with a *), accurate numbers for graduate output cannot be calculated with the available data.

The low graduate output is a serious problem which can be solved within the universities. Closer inspection of Colombo shows that most of the dropouts occur within the first year of study. Once the students are established in the program, they tend to stay and complete the degree. The data indicate that without any increase in funds, just by revising the current policies, improving the degree programs and understanding the problems faced by students, the graduate output can be substantially increased.

2.5 Postgraduate output

The output of postgraduate programs shows that the universities of Colombo, Kelaniya and Sri Jayewardenepara are the highest contributors (see Figure 3). In fact, between the years 1998-2001, nearly 100% of the postgraduates were produced by these three universities. In 2002, they had produced 74% of the total output. For a well established and reputed university, the postgraduate output of Peradeniya has been extremely poor (assuming UGC published data are correct). The percentage of graduate output shows that for both the university of Sri Jayewardenepura and Colombo, the efficiency of producing a postgraduate is slightly above 40% while it is at 26% for Kelaniya.

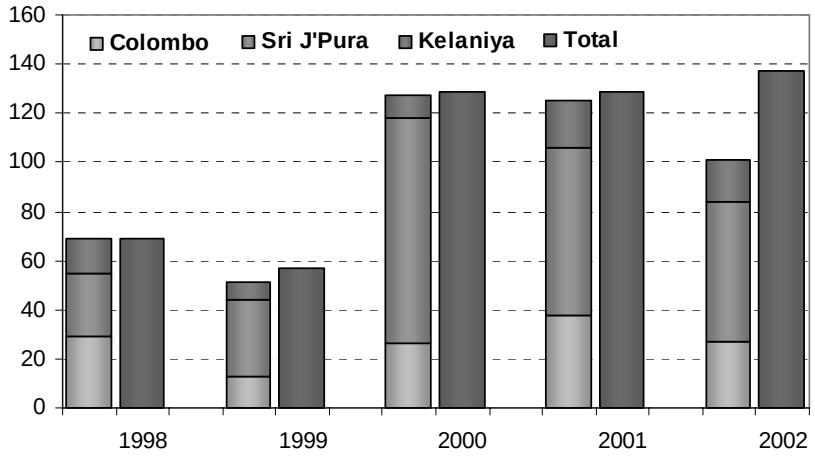

Figure 3: Postgraduate output (1998 - 2002). In each pair, the right-hand side bars indicate the total output and the left-hand size bars indicate the sum of outputs of Colombo, Sri Jayewardenepura and Kelaniya.

2.6 External or distance learning

Published data show that altogether there are about 26,000 undergraduate students registered in the public university system external degree programs (apart from the Open University). These students only sit for the university examinations and are not provided with any course materials or instructions and only about 10% graduate. In addition, the Open University has about 6,400 students enrolled in their external degree programs and about 6% of them graduate. The enrolment figures for the external degree programs are somewhat misleading since students may take many years to complete their degree. However, the enrolment figures indicate the existing labour market demand of students to obtain degree qualifications.

Although external science degrees are offered by several public universities (Peradeniya, Kelaniya and Eastern University), the graduate output has been virtually zero. The Open University produces close to 160 science graduates a year. This number is also quite poor considering the Government investment and the student enrolment (nearly 3000). Although the degrees are different, similar numbers are produced by the BIT external degree offered by the University of Colombo without any financial commitment from the Government. Thus, the Open University must look into improving the efficiency of their programs to increase the graduate output. The graduate output from the BIT examinations shows that 94% of the BIT graduates are from science streams (Physical - 67% and Biological - 27%). This in fact supports the idea of expanding IT training in the science streams of the public universities [4]. In addition, the universities in metropolitan areas could introduce technology oriented multidisciplinary external degrees.

3. FINANCING EDUCATION

3.1 Government grant

The Government of Sri Lanka invests a substantial amount on education annually. The total government budget for education is about SLR 40 billion [1] which is roughly 8% of the total Government expenditure and 3% of the national income. Compared to South Eastern countries Sri Lanka still devotes a slightly lower share (roughly 1% less) to the education budget. When it comes to university education, the total government grant is about 6 billion which is roughly 14% of the total education budget and 0.5% of the national income. Annually, universities receive about 850 million as capital expenditure and 3.5 billion as recurrent expenditure through the Government grant.

3.2 Distribution of funds

The distribution of funds among the universities varies. Among the 11 universities offering science subjects, the 6 largest universities which have 90% of the total number of students on roll receive 82% of the total allocation. Surprisingly, the University of Peradeniya which has only 16% of the students on roll and is the 2nd largest university in terms of students on roll receives 23% (almost 1/4) of the total budget (see Figure 4). The University of Colombo which is the largest university in terms of students on roll receives only 14% of the total budget. In general, all universities depend on the Government grant they receive and only generate about 8% to cover the total expenditure. Except for Colombo, Peradeniya, Sri Jayewardenepura and Kelaniya, all other universities generate less than 4% of the grant they receive.

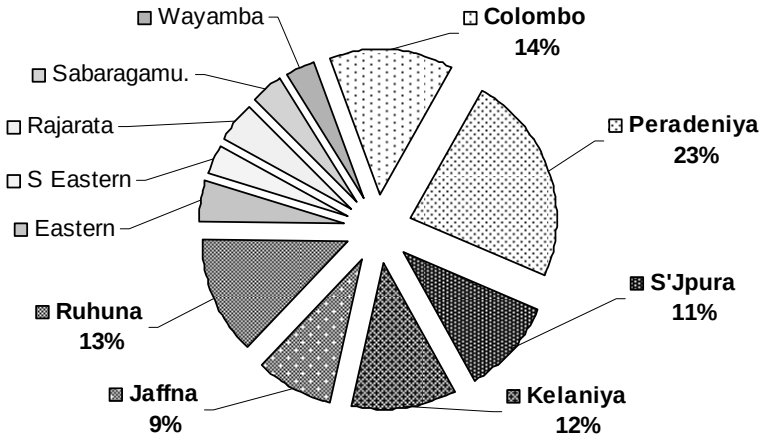

Figure 4: Fund distribution among universities (2003). Peradeniya receives roughly 1/4 of the total government grant.

When all universities are taken together, the share of capital expenditure is about 17% of the total expenditure. Among the 6 largest universities, this varies from 19% (highest - Sri Jayewardenepura) to 8% (lowest - Peradeniya). The share of fund distribution among various sub-components shows that, all institutions taken together spend 50% of their funding on academic services (see Figure 5). The amount spent on quality inputs is roughly 7%. The amount received by the universities from the UGC has no relationship to their individual performance. Neither is there a separate quota for investing in quality inputs.

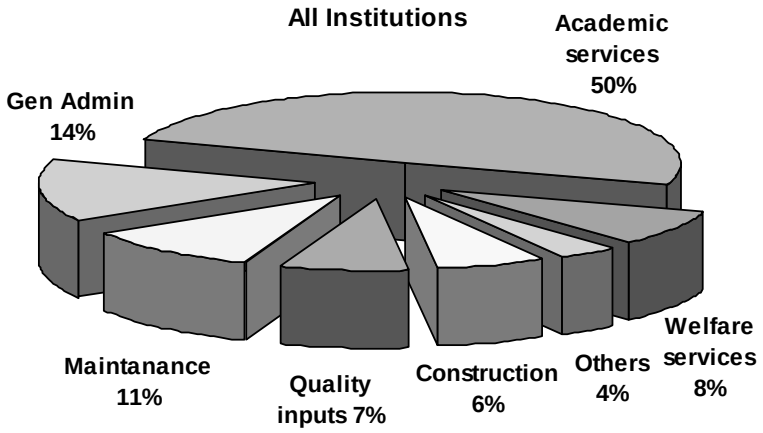

Figure 5: Sub components of total university education expenditure (2003).

3.3 Cost of producing graduates

Published data show that the unit cost of producing a graduate is SLR 65,697 (79% of GDP per capita). This is followed by technical education, SLR 14,834 (18%), secondary education, SLR 7,481 (9%) and primary education, SLR 6,741 (8%). This is generally typical for an education system with primary education being the least expensive and university education being the most expensive [1].

The UGC statistics show that there is a great variation among universities in regard to the unit recurrent cost of producing graduates (about 40,000 – 120,000 rupees per student per year). It was seen that in general, the unit cost is related to student enrolment, with smaller universities experiencing high unit costs and larger universities experiencing smaller unit costs. The exception to this rule is the University of Peradeniya (90,000 rupees per student per year). This may be due to their excess non-academic staff, high maintenance cost of spacious landscape and residential facilities. The best universities are Kelaniya, Sri Jayewardenepura, Colombo and Jaffna where the unit recurrent cost varies around 40,000 – 50,000 rupees per student per year.

A true unit recurrent cost of producing a science graduate can be estimated by analyzing the recurrent cost against the graduate output (see Table 3). The analysis shows that the unit recurrent cost varied from SLR 295,000 (best - Colombo) to SLR 422,000 (worst - Kelaniya) in 2002. Time trends show that this has been on the rise and several expensive universities will pass the unit recurrent cost of SLR 500,000 per student per year after 2004.

Table 3: Unit recurrent cost of producing science graduates (2002).

University	Recurrent cost (SLR)	Graduate output (per year)	Unit recurrent cost (SLR)
Colombo	84,550,000	287	295,000
Peradeniya	78,849,000	227	347,000
Sri J'pura	60,087,000	144	417,000
Kelaniya	74,678,000	177	422,000
Jaffna	50,405,000	139	363,000
Ruhuna	64,966,000	176	369,000
Eastern	18,777,000	47	400,000

3.4 Student-staff ratio

The student-staff ratios among the 7 oldest universities offering science subjects are shown in Table 4. The four universities, Colombo, Peradeniya, Kelaniya and Sri Jayewardenepura perform better than the UGC norm (10:1). In fact, for Colombo this ratio is much higher (17:1) than the UGC norm. The two universities, Ruhuna and Eastern fall below the UGC norm and have excess staff compared to the students on roll. In general at most universities (including the new small universities) the student-staff ratio stands at a reasonably satisfactory level.

Table 4: Student-staff ratios and graduate output per staff member.

University	Students on roll	Academic staff	Student-staff ratio	Output per staff member
Colombo	1466	87	16.9	3.3
Peradeniya	1297	104	12.5	2.2
Sri J'pura	1055	74	14.3	1.9
Kelaniya	1233	92	13.4	1.9
Jaffna	748	75	10.0	1.9
Ruhuna	1316	162	8.1	1.1
Eastern	198	40	5.0	1.2

In contrast to this, the science graduate output per staff member in all universities is at a very low level. The best is the University of Colombo which produces 3.3 graduates per academic staff member per year. The lowest is Ruhuna which produces only 1.1 graduates per academic staff member.

When the total non-teaching staff is compared, the University of Peradeniya shows far excess staff compared to all other university. Although Peradeniya is the 2nd in terms of students on roll, it has over 1000 more non-teaching staff members than any other public university. This in fact may be one of the main reasons why Peradeniya, which absorbs 1/4 of the total government grant, is one of the most expensive universities with regard to per unit recurrent cost of producing a graduate (all disciplines combined).

4. STUDENT EMPLOYEMENT

4.1 Unemployment rates

There are no reliable survey data available to estimate the unemployment rates among the science graduates produced by the various universities. However, two recent studies [5-6] provide some information on the science graduates produced by Colombo and engineering graduates produced by Moratuwa. Since both universities are located in metropolitan environments and attract the best students within their disciplines, the data can be compared to get insight into the job prospects of the graduates.

Table 5: Employment patterns of engineering and science graduates [5].

Sector	Engineering (Moratuwa)	Physical Science (Colombo)	Biological Science (Colombo)
University teacher	21.1	13.7	12.2
Public sector	4.2	12.5	16.7
Private sector	50.3	53.6	47.8
Clerical & other	8.5	9.6	13.3
Unemployed	15.9	10.7	10.0

The surveys show that 16% of the engineering graduates are unemployed while the same for science graduates is at 10-11% (see Table 5). These figures are somewhat misleading since universities tend to recruit their own graduates to temporary positions within the universities after graduation (21% for Moratuwa and 13% for Colombo). If the unemployment numbers are corrected for this effect, unemployment among engineering graduates rises to 21% whereas the same for science graduates rises to 14%. One reason for the high unemployment of engineering graduates compared to science

graduates could be the limited availability of public sector openings directly related to their training. The private sector absorbs roughly 50% of the engineering and science graduates.

The same surveys provide insight into the relationship between the performance of students at the G.C.E. A/L examination and unemployment. For sciences, high unemployment rates are observed for those who enter university in their 3rd attempt (38% for Physical and 19% for Biological). However, they represent only 11% and 19% respectively of the total intake. It is not clear whether the high unemployment is due to their performance at the university or related to factors such as their age.

4.2 Further training

Table 6 shows the additional training of engineering and science graduates. Compared to engineering graduates (15%), a higher percentage of science graduates tends to acquire additional training (42% for Physical and 52% for Biological). Data are unavailable to determine whether this training is obtained while at the university or before/after. Generally, engineering graduates tend to train in accountancy (71%) while physical science graduates tend to train in computing (58%). Biological science graduates do not show any marked preference and they obtain training in a wide range of areas. Across the three disciplines, accountancy and computing seem to be the two preferred areas.

Table 6: Additional training of engineering and science graduates [5].

Category	Engineering % (Moratuwa)	Physical Science % (Colombo)	Biological Science % (Colombo)
Accountancy	71	30	29
Computing	14	58	28
Marketing	11	4	11
Law	-	-	11
Other	4	8	21
Percentage having additional training	15	42	52

5. WHO IS BENIFITING?

It is interesting to see whether the present education system actually helps the poor. The survey data show that enrolment has a strong dependency on parental education [6]. The Education level of the father or the mother of about 85% of the students entering the university is at G.C.E O/L and above (see Figure 6). However, 90% of the households

that fall below the national poverty levels are those whose head of the household has an education level which is below the G.C.E. O/L [7]. Thus, from the students who follow degree programs in public universities, 14% can be considered as poor.

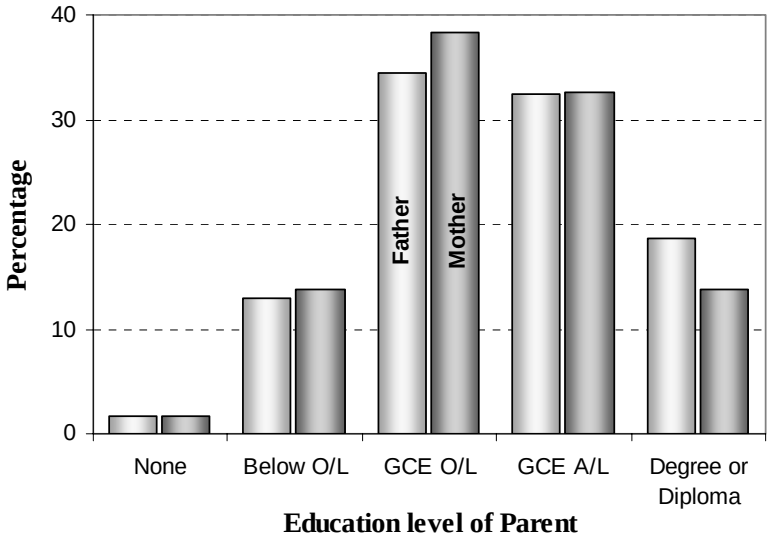

Figure 6: Education level of the parent. In each pair of columns: Left column – Father, Right column – Mother [6].

When tertiary education is considered (universities and other advanced technical institutes), published data show that 50% of those who are enrolled in tertiary education come from the highest consumption quintile (top 20% of the income bracket) [1]. Only 8% from the lowest quintile are enrolled in tertiary education. Thus, of those who are enrolled in public universities and other advanced technical education institutes, 92% can be considered as none-poor.

6. CONCLUSIONS

The published data show that 18% of the children drop out at the end of the compulsory education cycle and from those who succeed, only 40% and 56% pass the G.C.E. O/L and A/L examinations respectively and less than 3% enter the university. Thus, a large percentage is barred from getting a university education and they are forced to find tertiary level education through private institutions.

The science graduate output at most universities is at a highly unsatisfactory level. By revising the currently practiced policies, improving the efficiency of the degree programs and understanding the problems faced by undergraduates, graduate output can be substantially increased (for most Universities nearly doubled).

The allocation of funds among universities is not satisfactory. Especially, fund distribution is not based on the performance of individual universities or the quality of the programs or the labour market need. Some universities indicate excess numbers of non-academic staff and thus incur higher unit recurrent costs of producing graduates. The government must implement firm policies in distributing funds among universities. The performance of individual universities must be evaluated on a regular basis especially on graduate output and graduate unemployment.

The cost of producing science graduates varies between the universities. In general, small new universities show high unit costs of producing graduates. This questions the current government policy of opening new universities rather than strengthening the already existing universities for expansions. The new universities are already suffering due to the non-availability of qualified academic staff and depend on hiring visiting lecturers to conduct their programs.

Published data show that, from those who are enrolled in the universities and advanced technical institutions, only 8% are from the lowest consumption quintile. From those who have enrolled in the public universities, only 14% fall below the national poverty line. Thus, one can question whether free education at the university level is actually benefiting the poor.

REFERENCES

1. Treasures of the Education System in Sri Lanka: Restoring Performance, Expanding Opportunities and Enhancing Prospects, The World Bank Human Development Unit, South Asia Region, ISBN: 955-8908-14-2 (2005)
2. Sri Lanka University Statistics, Compact Disk (CD), Management Information Systems Division, University Grant Commission (2003)
3. UGC circular for student preferences
4. Information Technology: Sri Lankan Perspective, D.U.J. Sonnadara, Presidential Address, Section E1 of SLAAS, Proc. 57th Annual Sessions, Sri Lanka (2001)
5. D. Kottahachchi, Employment prospects of graduates from selected Sri Lankan Universities, Sri Lanka Labour Gazette, Vol 54, No 1, (2003)
6. D. Kottahachchi, Employment pattern of students graduated from the University of Colombo in 2002 and 2003, Sri Lanka Labour Gazette, Vol 55, No 2, (2004)
7. Millennium Development Goals, The World Bank Human Development Unit, South Asia Region, forthcoming (2005)