CHAPTER 8

Performance of academically-at-risk medical students in a problem-based learning programme. A preliminary report.[10]

Abstract

***Introduction*.** Racially segregated schooling, a legacy of Apartheid policies, continues to hamper education in South Africa. Students entering university from suboptimal circumstances are at significant risk of demonstrating poor academic performance and dropping out of their programmes. Attempts to address the educational needs of these students have included the introduction of extended medical programmes at several universities. Such a programme, the Academic Development Programme (ADP), was implemented at the University of Cape Town in 1991. Over the past decade the programme has graduated more than 100 students. Upon implementation of a new problem-based learning (PBL) programme in 2002, the Academic Development Programme was discontinued and all students were entered directly into the new PBL programme. Students who demonstrated a need for additional academic support by the end of the first semester entered the Intervention Programme for one year before proceeding to the second semester of the PBL programme.

Purpose. An interim analysis was performed to compare the retention rates and academic performance of academically-at-risk students in the new PBL programme and the ADP.

Methods. The records of all academically-at-risk students entering the ADP (1991-2000) and the new PBL programme (2002) were reviewed. Retention rates for all years of study, and academic performance in the 4th year clerkship courses of the respective programmes were compared.

Results. A total of 239 academically-at-risk students in the ADP and 43 at-risk students in the new PBL programme were studied. The median retention rates, per year of study, for at-risk

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students in the problem-based learning programme were significantly better than for at-risk students in the ADP ($p < 0.02$). Academic performance of the at-risk students in all the 4th year clinical clerkship courses of the PBL programme was significantly better than the mean performance over 10 years for at-risk students in the same 4th year courses in the ADP.

Conclusion. The introduction of problem-based learning at the University of Cape Town has not had a deleterious effect on the performance of academically-at-risk medical students. Interim analysis suggests that retention rates and academic performance in the PBL programme are better than those achieved in the extended traditional programme.

Introduction

Before the advent of a democratically elected government in 1994, Black schools in South Africa were run by a separate and less resourced Department of Education and Training. Since 1995 race-based distribution of educational resources has been abolished, but significant differences remain and the majority of Black South Africans continue to be educated in suboptimal circumstances. Overcrowded classrooms, inadequately trained teachers and insufficient educational resources, including basic textbooks, are some of the many limitations these students continue to face. The principal reason for this ongoing inequality is that upgrading of services, particularly providing adequately trained teachers at previously Black schools, will take many years to complete. Because Blacks constitute 93.3% of South Africa's 13.7 million school-going population,[1] previously White schools, catering for less than 7% of South African school-goers, are too limited in number to absorb the large number of Black students. Hence access to good quality education is currently available to only a tiny minority of Black South Africans.[2-5] Students attending previously Black schools where educational inequality persists are referred to as 'educationally disadvantaged'. It is thus not surprising that when students, emerging from these educationally disadvantaged circumstances, enter university they are at risk of performing poorly despite their best efforts and innate talents.

Some South African medical schools are addressing this legacy of Apartheid by selectively admitting such academically-at-risk students to medical programmes that provide additional educational support and permit students to complete the standard six-year programme over an extended period of time; usually one additional year. At the University of Cape Town (UCT) an extended medical programme, called the Academic Development Programme (ADP), was put in place in 1991.[6] This programme has facilitated the successful graduation of more than 100 academically-at-risk students, representing 12.6% of all medical graduates in the past decade, from its inception in 1991 until its replacement with a new strategy contained within a PBL-based curriculum which was implemented in 2002.

Given the success of the ADP at UCT, concern was expressed regarding the potentially adverse impact of the introduction of problem-based learning (PBL), in the new curriculum, on the performance of academically-at-risk students. Indeed, the concerns expressed were identical to those voiced at the University of New Mexico School of Medicine (UNMSOM) when PBL was first introduced there in the late 1970s.[7] In contrast to the decision taken at UNMSOM, which was to retain all academically-at-risk students in the traditional programme, it was decided to admit all students, including academically-at-risk students, directly to the new PBL programme and carefully monitor their progress. Students who demonstrated a need for additional academic support by the end of the first semester entered the Intervention Programme

for one year before proceeding to the second semester of the PBL programme. This paper provides a preliminary report on the retention and academic performance of academically-at-risk students in the new PBL programme implemented in 2002.

Methods

Matriculation examinations score

At the end of the final year in high school, all Grade 12 South African students write the national high school matriculation examinations, namely the national Senior Certificate Examinations, which serve as qualifying examinations for entry into tertiary institutions. Prior to 1996, school-leaving examinations were nationally set for Black students and provincially set for White students. Since 1996 the new government has attempted to standardize the final school-leaving examination process. Some progress has been made in this regard. Six nationally set papers have been introduced and racial segregation of candidates no longer exists; provincial differences do however persist.[9-11] Despite the lack of a uniform standard, the matriculation examinations results represent the only record of prior academic performance and are used by all medical schools in South Africa to select medical school entrants.

The Faculty of Health Sciences at UCT ranks applicants for the MBChB degree programme using the results of the Senior Certificate Examinations to compute a matriculation examinations score. The latter is derived by converting Senior Certificate Examinations results from a symbol score to a numerical score ranging between one and eight, with an A symbol earning eight points, a B symbol earning seven points, etc. An applicant's matriculation examinations score is the sum of points earned for a set of six subjects which must include Physical Science, Mathematics and English. The maximum score a candidate can achieve is 48. The minimum matriculation examinations score considered for entry into the MBChB programme at UCT was empirically set at 42 more than 20 years ago. This was largely based on the highly competitive matriculation examinations results of medical school applicants and data suggesting poorer graduation throughput rates for students entering the programme with a lower matriculation examinations score. A minimum score of 42 was considered representative of an overall B average for the Senior Certificate examinations (six B symbols = 42), although a number of symbol combinations could achieve the minimum score, e.g. three A symbols and three C symbols.

Students

The academic records of all students entering the MBChB programme at UCT between 1991 and 2002 were reviewed. There were two admission categories of students: (a) first-time

university entrants - students with no previous university experience, and (b) university entrants with previous university experience - students entering the MBChB programme with one or more years of university experience, including students transferring from medical programmes at other universities within South Africa. For the purposes of this study only first-time university entrants, approximately 75% of all entrants, were studied. First-time entrants were defined as academically-at-risk if they had (a) obtained a matriculation examinations score between 35 and 41 (out of a possible 48), and (b) attended a school considered to be educationally disadvantaged on the basis of prior racial segregation. All other first-time entrants with a matriculation examinations score of 42 to 48 were considered to be academically-not-at-risk regardless of the type of school they had attended i.e. they could have attended a Black or White government school or a private school. Academically-at-risk students were entered into the ADP, while all other entrants, including those with prior university experience, were admitted to the standard six-year programme. Owing to the transition from a traditional programme to a PBL programme in 2002, all students who had entered the ADP in 2001 were transferred directly into the first year of the new PBL programme in 2002. This cohort of academically-at-risk students, who transferred from the ADP to the new PBL programme, was the main focus of this study.

Academic Development Programme

In 1991, when it was decided to widen student access to the MBChB programme at UCT, a 7-year Academic Development Programme was commenced. The principal purpose of this programme was to selectively admit academically-at-risk students (previously defined) into an extended MBChB programme aimed at improving the ethnic mix of medical graduates from UCT. In this programme, run from 1991-2001, students received additional educational support in the form of small group tutorials, as required, and were expected to complete the first three pre-clinical years of study over four years, i.e. the MBChB programme was effectively lengthened by one year to seven years. In all other respects the extended programme students attended the same learning activities and wrote the same tests and examinations as the standard six-year MBChB programme students i.e. lecture-based teaching in the pre-clinical years and clerkship-based in the remaining three years.[6]

Problem-based learning programme

In 2002 problem-based learning was introduced into the first two-and-a-half years of the six-year MBChB programme at the University of Cape Town. The PBL component of the programme is largely campus-based; students have limited community-based clinical exposure during clinical skills training modules that run concurrently with the PBL programme. The remaining three-and-a-half years of the programme have remained largely unchanged; clinical

training is structured around clerkship attachments located at community hospitals, clinics and other primary health care service sites. The PBL model used in the first 30 months of the MBChB programme is based on the "seven jump" model described by Maastricht University.[12] Paper-based cases, derived from authentic clinical material, are written in such a way that basic sciences (Physiology, Anatomy, Medical Biochemistry), clinical sciences (Anatomical Pathology, Chemical Pathology, Microbiology, Pharmacology), population health (Public Health, Primary Health Care) and psycho-social and cultural issues are addressed in an integrated manner. Separate codes for these courses have been abolished and all courses are integrated under a single course code. A "core curriculum" blueprint is used to eliminate overlap and ensure that all relevant issues are addressed within the cases used. Students, allocated to groups of 10 or less, meet twice a week for three hours in groups that are facilitated. Facilitators are not content experts and serve only to guide the group activities and ensure that students derive learning objectives concordant with those set by the faculty. All facilitators complete a period of training prior to undertaking facilitation duties, and ongoing two-weekly staff training is also provided. During the first session the case is worked through and learning objectives are identified by the group. During the second session, groups discuss the information gathered about their learning objectives, clarify remaining issues, and refine further learning objectives, if necessary. In the third session they "wrap up" the case discussion and provide evaluative feedback on the case as well as the learning process. The PBL process is supported by additional educational input provided in the form of lectures, laboratory practical sessions and small-group tutorials. The group composition is determined by faculty, and students are selected to produce groups with a range of academic ability and equitable gender and ethnic representation. Groups change after each semester which varies in length from 12-16 weeks.

Data analysis

Retention rates, expressed as the percentage succeeding of those initially entering the programme, were calculated for each year of study for academically-at-risk students in both the ADP (1991-2000) as well as the PBL (2001) programme. The Statistica version 7 software package (StatSoft Inc., Tulsa, USA) was used to calculate (a) median retention rates per year of study, and (b) mean scores achieved in the 4^{th} year examinations of Internal Medicine, Obstetrics, Public Health, Primary Health Care and Psychiatry for the ADP cohort (1991-2000) and the PBL cohort (2001). Chi-square analysis was used to compare median retention rates of academically-at-risk students entering the ADP (1991-2000) and PBL (2001) programmes. The student t-test was used to compare (a) mean matriculation examinations scores, and (b) mean 4^{th} year examinations scores for academically-at-risk students admitted to the ADP (1991-2000) and PBL (2001) programmes. For all purposes of analysis, a p-value of 0.05 or less was considered significant.

Results

Academically-at-risk ADP entrants 1991-2000

A total of 239 academically-at-risk students entered into the seven-year ADP over the 10-year period 1991-2000. This represented 16.1% of the total number of admissions to medical school during this period. These students had a significantly lower mean (SD, 95% CI) matriculation score, 37.1 (2.6, 36.8-37.4), than entrants to the standard six-year programme, 44.4 (2.5, 44.3-44.6) ($p<0.00001$).

Academically-at-risk PBL entrants 2002

Forty three academically-at-risk students were transferred from the ADP to the first year of the new PBL programme in 2002. Their mean matriculation score, 39.7 (1.4, 39.3-40.2), was better than the mean score for the 1991-2000 ADP cohort ($p<0.00001$), but significantly less than the mean of the standard programme cohort ($p<0.00001$).

Student retention rates

Figure 1 demonstrates the retention rates of academically-at-risk students entering the PBL programme in 2002 as compared to the worst and best retention rates achieved by the 10-year cohort of academically-at-risk students entering the ADP. The retention rates for all academically-at-risk students are shown in Figure 1a; the retention rates for all at-risk students progressing through the programme at the minimum expected rate (without repeating a year of study) are shown in Figure 1b. At-risk students in the PBL programme performed significantly better than the worst performance depicted in the ADP for (a) all registered students (Chi-square = 49.2, df = 4, $p < 0.00001$) (Figure 1a), and (b) all students progressing at the minimum expected rate (Chi-square = 125.1, df = 4, $p < 0.00001$) (Figure 1b). The performance of at-risk PBL entrants was not significantly different to the best performance achieved over 10 years for all ADP students (Chi-square = 1.4, df = 4, $p < 0.85$) (Figure 1a), and, more importantly, not significantly different to all ADP students progressing at the minimum expected rate (Chi-square = 7.6, df = 4, $p < 0.11$) (Figure 1b). Figure 2 shows the per annum retention rates for academically-at-risk PBL entrants in 2002 as compared to the median retention rates for academically-at-risk ADP entrants over the 10-year period, 1991-2000. It will be noted that the retention rates diverge; the trend being statistically significant in Figure 2(b) (Chi-square 11.3, df = 4, $p < 0.02$).

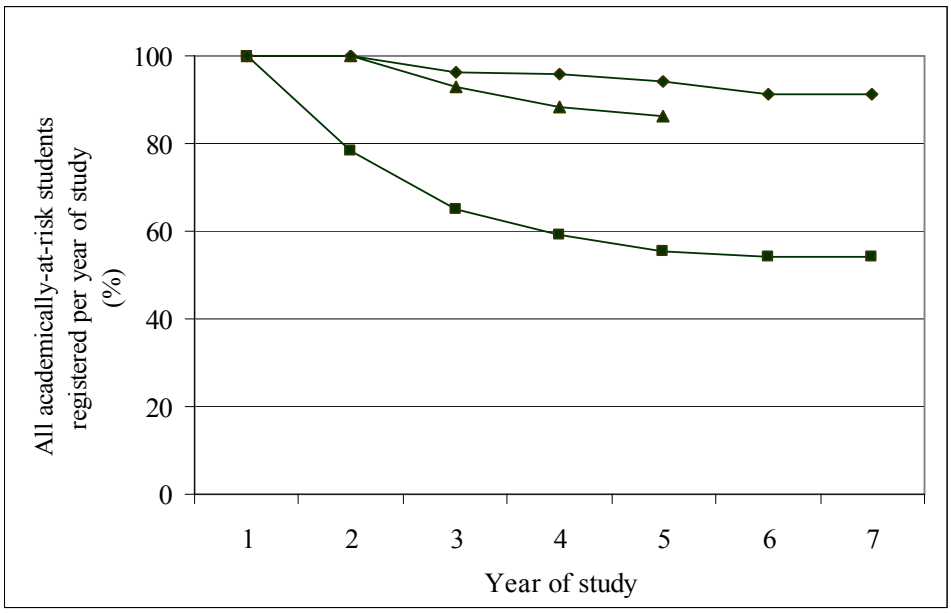

Figure 1(a). *Per annum retention rates of all academically at-risk students entering the Academic Development Programme from 1991-2000 (n = 239, -■-■- = worst retention rates, -♦-♦- = best retention rates) and the PBL programme in 2001 (n = 43, -▲-▲-). Retention rates expressed as percentage remaining of those initially entering programme.*

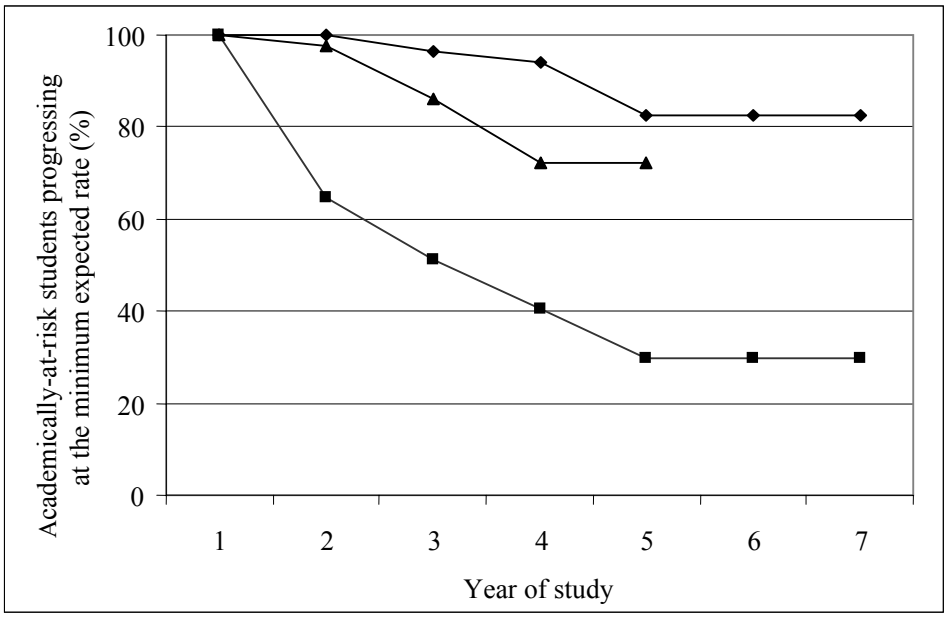

Figure 1(b). *Per annum retention rates of all academically at-risk entrants progressing, at the minimum expected rate, through the Academic Development Programme from 1991-2000 (n = 239, -■-■- = worst retention rates, -♦-♦- = best retention rates) and the PBL programme in 2001 (n = 43, -▲-▲-). Retention rates expressed as percentage remaining of those initially entering programme.*

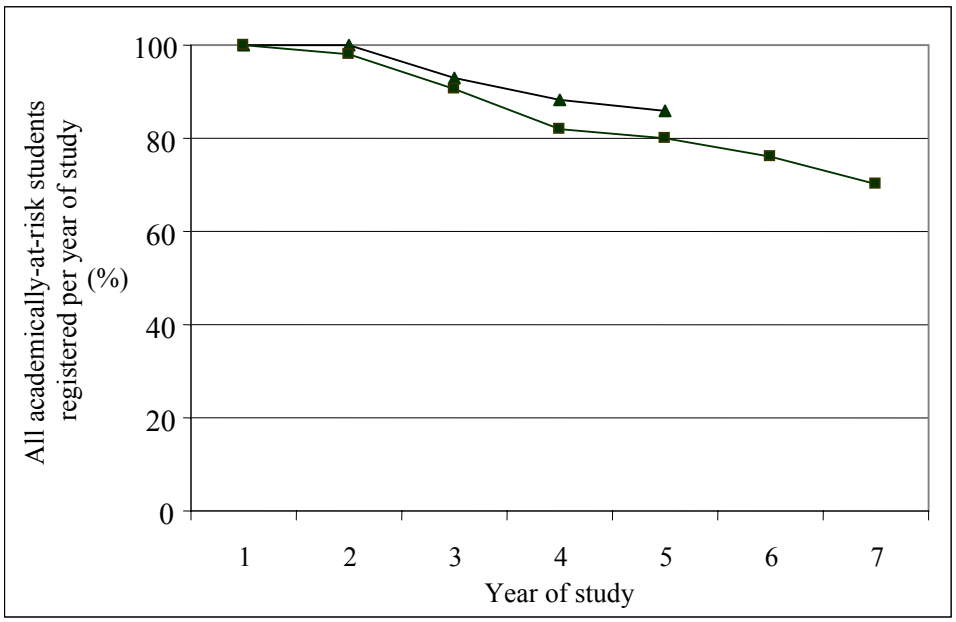

Figure 2(a). *Per annum median retention rates of all academically at-risk students entering in the Academic Development Programme between 1991-2000 (n = 239, -■-■-) and the PBL programme in 2001 (n = 43, -▲-▲-) at UCT. Retention rates expressed as percentage remaining of those initially entering programme. Chi-square = 1.05, df = 4, p < 0.90.*

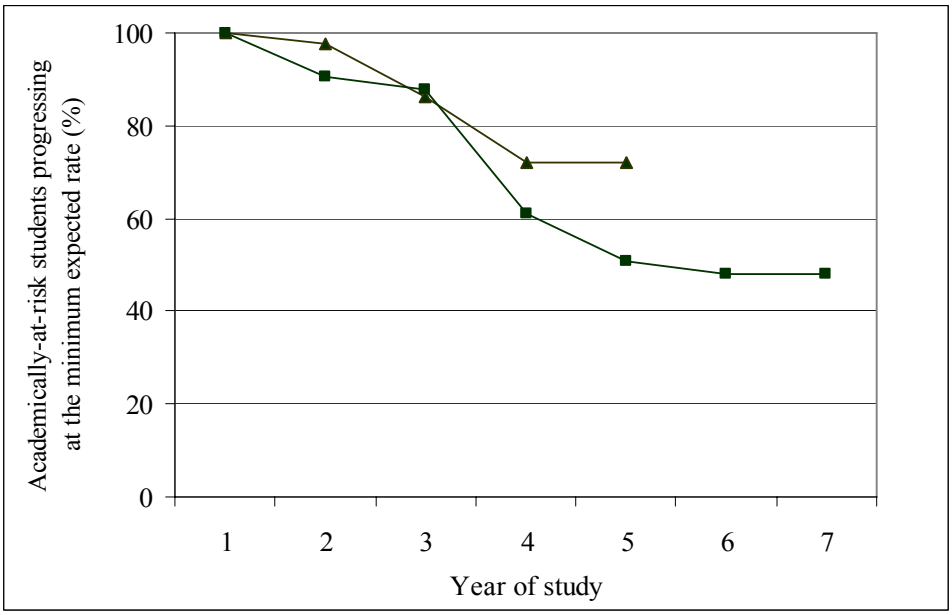

Figure 2(b). *Per annum median retention rates of all academically at-risk entrants progressing, at the minimum expected rate, through the Academic Development Programme from 1991-2000 (n = 239, -■-■-) and the PBL programme from 2001 (n = 43, -▲-▲-). Retention rates expressed as percentage remaining of those initially entering programme. Chi-square = 11.34, df = 4, p < 0.02.*

Duration of study prior to dropout

Review of the dropout data for the 10-year ADP cohort shows that 73.5% of student dropouts occurred within the first four years of the extended programme. The trend was similar for at-risk students entering the PBL programme in 2002.

Reasons for student dropout

The overwhelming majority of students who dropped out of the ADP over the 10-year period, numbering 65 of 68 (95.6%), were excluded from further study due to inadequate academic performance. Only three students in 10 years voluntarily withdrew from the programme. The trend for at-risk students in the PBL programme was similar; four students were excluded while only two withdrew.

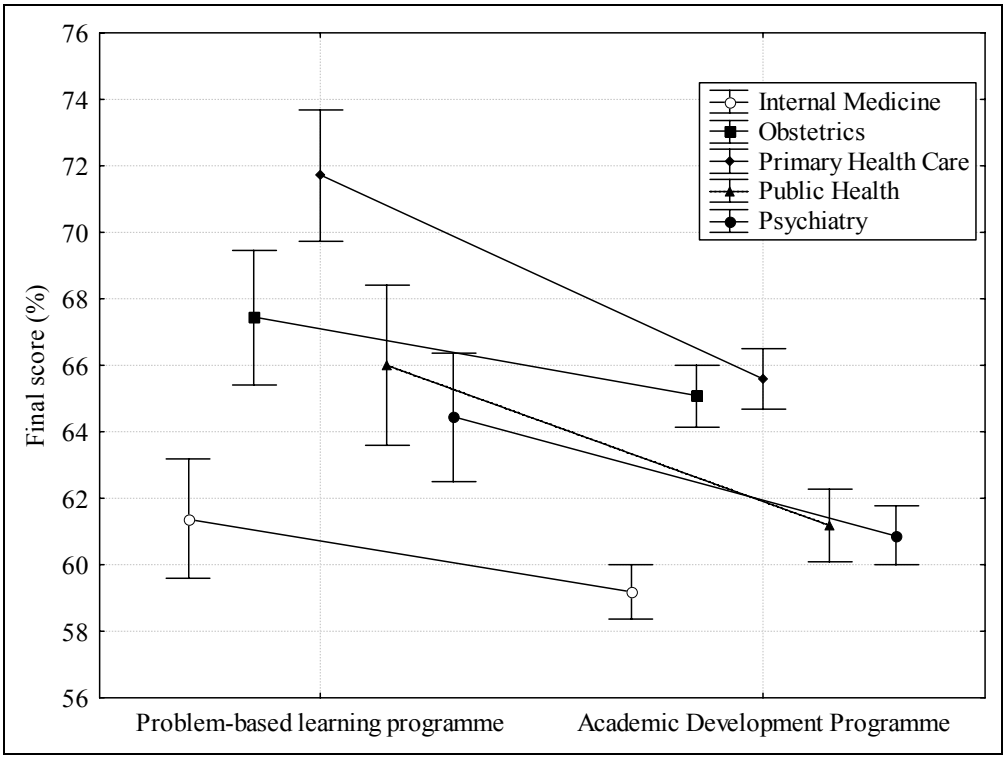

Figure 3. *Comparison of the mean (± 95% CI) academic performance in the 4th year clinical clerkship courses for academically-at-risk students in the PBL programme (n=32) and the Academic Development Programme (n=163). Internal Medicine $p < 0.02$, Obstetrics $p < 0.03$, Primary Health Care $p < 0.00001$, Public Health $p < 0.001$ and Psychiatry $p < 0.001$.*

Fourth year examinations results

At-risk students in the PBL programme performed significantly better in the final examinations of all the 4th year clinical clerkship courses when compared to the mean performance, over 10 years, of ADP students in the equivalent year of study (Figure 3).

Discussion

This interim analysis of the recent implementation of problem-based learning at the University of Cape Town, South Africa, suggests that PBL may reduce dropout rates and improve the academic performance of university students who have weaker prior educational preparation. The retention rate of academically-at-risk students admitted to the PBL programme is significantly better than that achieved by similarly disadvantaged at-risk students in the Academic Development Programme (extended traditional programme) offered at UCT between 1991 and 2000. In addition to better retention rates, academically-at-risk students in the PBL programme also demonstrated superior performance in each of the five courses offered in the 4th year of study, the first of the final three clerkship years of the MBChB programme. Comparison of the clinical clerkship course scores was considered valid since the clinical clerkship years of the programme have remained largely unchanged over the past decade (1995-2005). Although minor adjustments to the composition of summative assessment packages in some of the courses have been made, since curriculum revision was undertaken in 2001,[13] major changes in assessment strategies have been avoided. It can thus not be argued that the improved academic performance of these students simply reflects a drop in educational standards or major changes in assessment practices. The average 4th year clerkship performance of academically-not-at-risk students has remained stable over the past decade, further refuting this point.

Academically-at-risk students who entered into the ADP in 2001, and transferred from the ADP to the PBL programme in 2002, were selected using the same criteria that were used to select ADP students between 1991 and 2000. The superior retention rates and academic performance of PBL students can thus not be ascribed to selection bias. It could, however, be argued that better performance in the new PBL programme simply reflects a general improvement in prior educational training at school level since the advent of a democratic government in 1994. For reasons explained earlier in the paper, political reform has not yet significantly impacted on the quality of education offered in the vast majority of 'educationally disadvantaged' schools that remain considerably less well resourced than previously White schools. Data reflecting the numbers of school students writing and succeeding in Mathematics and Physical Science, often viewed as suggestive of the quality of an educational system,

provide good evidence to support this statement. Although Black students comprised 78% of the population writing the Mathematics matriculation examination in 2003, they represented only 26.8% of the successful candidates for this subject.[2]

The importance of these findings cannot be underestimated in the South African context. Recent international trends in educational reform have greatly influenced South African medical schools, resulting in the local implementation of problem-based learning. Educational reform has moreover taken place in the context of a need for educational redress in a society still hampered by the inequalities of previous Apartheid policies. Data suggesting that curriculum change does not have a negative impact on the academic progress and performance of educationally disadvantaged students is sufficiently important in this context; the demonstration that retention rates and clerkship performance in a PBL programme are better is extremely significant and reassuring. Although these findings represent the progress of only one cohort of students to date, they have considerable potential implications for medical education in South Africa in the face of the relatively greater financial costs inherent in PBL programmes.[14]

The international relevance of our data in countries where attempts to improve medical school access for educationally disadvantaged students is also being undertaken e.g. UK, USA, Canada and Australia, deserves special consideration. Our findings must be viewed in the larger context of the current situation regarding education in South Africa. Educationally disadvantaged students represent the majority of school-going South Africans. Those who manage to complete their secondary education, achieved only 20% of South Africans over the age of 20 years,[1] in the harsh circumstances already described clearly represent the most resourceful, motivated and innately talented candidates. It is thus fair to say that academically-at-risk students entering medical schools in South Africa, while clearly educationally disadvantaged when compared to their medical school peers, represent the best candidates selected from a vast pool of students receiving inferior schooling. For this reason it is imperative in the South African context to identify these candidates and provide them with an education that facilitates their growth and development. This does, however, differ significantly from other centres where academically-at-risk candidates usually represent a "minority" group, e.g. Aboriginal people of Australia. The results of this study should thus be applied with due caution to circumstances where educationally disadvantaged students, attempting to access medical training programmes, represent "minority" groups.

Why academically-at-risk students should specifically benefit from problem-based learning, as compared to traditional programmes, is a critical question raised by the findings of this study. Indeed, concerns about the ability of educationally disadvantaged students to cope with the relative lack of structure of PBL have previously resulted in their exclusion from such programmes elsewhere in the world.[7] Since these findings have only just emerged from our

interim analysis, we are still exploring potential reasons for our observation. The authenticity of the observation is, however, supported by recent papers from the Walter Sisulu University (formerly the University of Transkei), a rurally-based South African medical school focusing primarily on the training of students from educationally disadvantaged backgrounds.[15,16] They observed a similar finding when comparing student attrition rates in their conventional programme (1985-1992) and PBL programme (1992 onwards).[15] These two papers from South Africa, including our own work, provide the first evidence that PBL programmes may specifically benefit academically-at-risk university students. Earlier work from the Walter Sisulu University,[17] suggests that PBL may benefit educationally disadvantaged students by impacting on their learning styles and producing more versatile learners. Further work is clearly needed to better define the components of PBL that particularly impact upon student performance. The findings of such research will be particularly important given the diversity of PBL methods in use.[18]

Contrary to our findings, reviews of published data attempting to demonstrate the educational benefits of PBL conclude that this educational method does not significantly benefit students in terms of knowledge, and is of marginal benefit only in terms of clinical skills and clinical reasoning.[14,19-23] These findings may be best explained by our observation that differential retention rates in traditional and PBL programmes produce student populations that are not comparable. This is particularly true if academically weaker students are retained in PBL programmes; they would tend to skew results and potentially obliterate any difference that may be observed between traditional and PBL programmes. This is a source of considerable debate in the recent literature.[20-26] Indeed, the lack of an observed difference in performance between such disparate cohorts as those described in this study provides good evidence of the educational benefits of a PBL programme.

The use of student retention rates to measure the success of a new curriculum is not widely practiced in the published literature.[15,19,22] However, tracking retention rates may constitute a very useful simple measure of early success whenever educational innovations are introduced. In the resource-constrained settings of the developing world, the successful throughput of students represents a significant fiscal saving and is thus an important parameter of success. This is certainly true at the University of Cape Town, where considerable effort has been made in the past decade to improve the throughput rate and academic performance of students from educationally disadvantaged backgrounds. This early evidence of the success of the new programme is welcome indeed.

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