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1. Introduction

Internationally, higher education institutions generally – and universities in particular – face increasingly complex challenges when it comes to the selection, retention and completion of students deemed desirable applicants (Terenzini, Springer, Yeager, Pascarella, Nora, 1996; Tinto, 1998; Pascarella and Terenzini, 1998; Scott, Yeld and Hendry, 2007). The challenge appears to consist of a number of important dimensions.

There is, firstly, the challenge of assessing and understanding the extent to which higher education applicants have been **adequately prepared** in their primary and secondary education **to cope with the academic demands** they will face on entry to, and during the course of, higher education study (Griesel, 2006; Yeld, 2006; Bohlmann and Braun, 2006; Cliff and Yeld, 2006; Frith and Prince, 2006). In many countries, a formal school-leaving examination is an important source of gathering information about the entry-level readiness of higher education applicants. Typically, this examination is administered nationally by a ministry responsible for secondary education policy and practice. Acceptable levels of achievement on this examination are ascertained and certificated such that higher education may, in theory at least, regard particular levels of achievement as being acceptable minima for entry into programmes of study. It has been assumed historically in this system that minimum levels of achievement imply that prerequisite knowledge and learning processes have been both taught and learned, and that the applicant is 'ready' to enter conventional programmes of study that are cognate with the subjects this applicant has offered for the school-leaving examination.

In the absence of a school-leaving examination, another internationally common approach to addressing the challenge of assessing school-leaving achievement and higher education readiness is the use of entry-level pencil-and-paper tests or sets of tests (see, for example, AARP, 2009; IELTS, 2009; SAT, 2009; TOEFL, 2009). The aims of these tests are also the assessment of what are believed to be the entry-level knowledge and processes required for applicants to cope with higher education study. These tests are, however, often developed independently of any national ministry of education and are frequently designed to be an assessment both of generic academic reading, writing and thinking ability and an assessment of fundamental disciplinary knowledge and concepts required on entry to higher education.

Assessment in such tests takes two common approaches: (1) they attempt to assess what knowledge has been learned by the individual in the secondary system and the test tasks are frequently criterion-referenced, i.e. the tests assess what has been learned against an anticipated and assumed minimum level of learning (see, for example, Foxcroft, 2006); and (2) they seek to ascertain whether an individual has the 'potential' to cope with higher education study even if certain minimum levels of knowledge may not have been adequately taught or learned (see, for example, Cliff, 2002; Cliff, Yeld and Hanslo, 2003; Cliff, Ramaboa and Pearce, 2007; Badenhorst, Cliff and Kidson, 2009, under review). In the former approach, tests are used to ascertain or calibrate levels of

knowledge and process assumed to have been learned at secondary school. Such tests are implemented in order to validate what has been learned at school or to enable higher education institutions to adopt a standardised approach to comparing the knowledge of applicants from a range of different educational experiences, backgrounds or levels of certification (see, for example, Pitoniak, Cliff and Yeld, 2008; Yeld, Prince, Cliff and Bohlmann, 2009). The latter approach – that of using tests to assess applicants' 'potential' – assumes that, even in cases where applicants have not developed the requisite knowledge and processes expected of an entry-level student, tests can assist with understanding whether the applicant will be able to be successful in spite of a lack of formal knowledge or process (Cliff and Hanslo, 2005; Cliff and Hanslo, 2009; Yeld, 2001). Such tests are implemented to assess for the presence of ability or abilities believed to be innate or latent, i.e. not necessarily directly related to formal learning or development (Sternberg and Grigorenko, 2002). Tests of potential worldwide arguably attempt to surface applicants' capacity to learn – or responsiveness to a learning opportunity (assumed to be inherent to the test itself) (Budoff, 1987; Campione and Brown, 1987; Feuerstein, Klein and Tannenbaum, 1991; Hessels and Hamers, 1993).

The use of entry-level testing is becoming more commonplace internationally. Worldwide, higher education institutions believe school-leavers to be less and less adequately prepared to cope with the typical demands of higher education study – failure and completion rates are increasing or completion is taking longer than the minimum time stipulated for an undergraduate study programme. Testing is used to attempt to understand the lower levels of preparedness in spite of applicants' school-leaving certification confirming apparently adequate preparation. And testing is also used to assess the readiness to learn (or potential) of applicants who have not necessarily been exposed to adequate preparation or whose school-leaving results are absent or uninterpretable in the context to which they seek access. This latter focus is especially relevant in the increasing numbers of cases internationally where students access higher education study from diverse backgrounds and levels of preparation.

This last focus points to a second dimension of the challenge facing higher education institutions with regard to selection, retention and completion. It is true that, in many parts of the world (certain Asian countries with low levels of migrant populations may be the exception), higher education institutions face the challenge of applicants seeking access from increasingly **diverse educational and experiential backgrounds** (Terenzini et al, 1996; Pascarella and Terenzini, 1998; Hill, 2002). A number of universal factors appear to have contributed to this diversity:

- the massification of higher education in the past approximately 30 years;
- economic imperatives, which have led to increasing participation rates in higher education;
- worldwide migration and the 'marketing' and portability of higher education offerings;
- technological globalisation and the 'virtual' university;
- increasing participation in higher education by adult learners, 'non-traditional' students; participation in lifelong learning
- need for social justice and equity.

In essence, this diversity can be seen in terms of demographics such as ethnicity; social class; language; geographic origins; and educational experience and history, including

previous exposure to higher education. The dimension of diversity presents particular challenges for higher education institutions in terms of developing a mission and policy to respond to this diversity. Put simply, universities need to decide whether they believe it is important to reflect the diversity of national (and regional) populations in the demographic compositions of their student bodies. And they need also to decide on the extent to which widening access to a diversity of students poses challenges for teaching, learning and assessment policies and practices. If diversity is to be addressed, it creates specific challenges of admitting to institutions constituencies of students who may not be educationally – or in other terms – as prepared to cope with the demands of higher education as might be students who have been schooled in well-resourced, middle-class, well-developed contexts.

It is clear, from the experiences of countries where widening access has been actively pursued, for example, South Africa, that students from poorly-resourced educational backgrounds cannot be viewed in preparedness terms as at the same level as students from well-resourced backgrounds (Cliff, 2007; Cliff and Hanslo, 2009). The following factors characterise the profile of students from educationally disadvantaged backgrounds. It is important to note that the backgrounds of such students do not necessarily reflect all of the following characteristics, but often are constituted of at least three or four of these. It is furthermore important to note that what makes students 'educationally disadvantaged', is both the presence and the extent of the characteristics in their backgrounds. No single factor on its own necessarily means students are educationally disadvantaged; and there has to be systemic and substantial evidence of the considerable deleterious impact of one or more of these factors for students' backgrounds to be classified as 'educationally disadvantaged'.

What follows, are the factors known to be associated with educational disadvantage in a country like South Africa:

- Poorly-resourced primary and secondary education (the student comes from a school where physical and educational resources have been limited, absent or – where present – under-utilised; schools have poorly qualified teachers; levels of motivation and aspiration are low; cultures of learning are almost absent);
- Low levels of parental income and education;
- Students are from ethnic, social class, linguistic or cultural minorities when viewed against these norms prevailing in the institutions to which they seek access;
- Students often come from rural communities where development and education levels are at considerable variance with the context to which they seek access;
- High levels of socio-economic under-development (for example, poverty) and psycho-social stress (for example, crime and violence) are present in the communities in which these students live;
- Students are often first-generation higher education applicants.

Given the aforementioned characteristics, it must be seen as remarkable and encouraging that numbers of students from such backgrounds manage to achieve academically; have high levels of motivation and aspiration for higher education; and seek to contribute to the development and upliftment of themselves and of the communities from which they originate. It is also clear – from testing of such students that seeks to identify the presence of academic talent in the relative absence of

achievement in the communities – that many such students have the capacity to cope with the demands of higher education (Zaaiman, Van der Flier and Thijs, 2000; Bryson, Smith and Vineyard, 2002). For reasons that relate to national development needs; equity and social justice; and the need to reflect the demographics of the national population in the demographics of universities, such students ought to be in higher education (Scott, Yeld and Hendry, 2007). If academic talent is assumed to be normally distributed in national populations, it must also be assumed that the educational achievement of educationally disadvantaged students has been severely compromised in certain cases for reasons that have nothing to do with their innate abilities.

A third dimension of the challenge to select, retain and graduate students for higher education relates to the **need to ensure appropriate and adequate forms of curriculum provision** to support teaching, learning and assessment. Given the levels of under-preparedness of many students; the difficulties that lie with the interpretation of formal school-leaving achievement; the identification, through testing, of academic 'potential' and the learning needs of students; and the diversity and wide-ranging educational backgrounds of students seeking entry into higher education, it is imperative that curriculum is dynamic and responsive to such factors (Burch, Sikakana, Yeld, Seggie and Schmidt, 2006). Furthermore, the high and increasing levels of student 'drop-out' from higher education in many countries suggest, at the very least, that support for teaching and learning should be increased and improved in order that nations can make the most of the educational capital that is latent or developed in its higher education students (Astin, 1993; Grayson, 2003; Cliff, Yeld and Hanslo, 2003).

Given the high levels of student 'drop-out' from higher education, it simply makes no sense to assume that it is solely the responsibility of students to make good their own apparent deficiencies, and it is also clear that many very good students are not necessarily graduating in standard (minimum) time for degree programmes. This is especially – but not uniquely – so for students from educationally disadvantaged backgrounds. For such students, creating opportunities – through, for example, testing for 'potential' – for them to access higher education is only one aspect of a response continuum that requires that they are:

- selected on appropriate and defensible selection criteria;
- placed in appropriate and augmented programmes of study, that are developed on the assumption that such students' levels of achievement are not necessarily a reflection of their capacity to cope with higher education study;
- supported holistically through curricula that provide the full range of academic; psycho-social; peer; mentor; information technology; and residence support systems;
- tracked and monitored throughout their degree studies, so that they can be supported when their studies falter for academic or other reasons – on the assumption that such students may need the full duration of their studies to become self-directed, autonomous learners.

It goes almost without saying that the above forms of curriculum provision may be appropriate for all students; not only for students from educationally disadvantaged backgrounds. The provision of adequate curriculum is, however, not an either-or choice: it is not either for 'conventional', 'advantaged' background students or for 'educationally disadvantaged' background students. In a resource-constrained

environment in higher education, this arguably means the sourcing of additional funding – with an appropriate rationale for this – for the provision of curriculum for educationally disadvantaged background students. Typically, such sources of funding can be sought through major international or national donor funding bodies or individuals; industry; corporates; social development agencies; government organisations; non-governmental bodies; and so on. Once programmes for educationally disadvantaged background students have been developed, implemented and assessed as successful, motivations can be developed within institutions – or outside – for the further funding and integration of such programmes in the academic life of institutions.

In the specific case of Costa Rica, there is increasing evidence of growing inequities, since, with the exception of the gender dimension, in recent years Costa Rica has experienced continuous declines in equity indicators. Increasing inequality among different socioeconomic groups and geographic areas has been observed. As a measure of income inequality, for example, the Gini coefficient is used to measure inequality in a range between 0 and 1, where a measure close to 0 equals greater equality and, by contrast, a measure closer to 1, equals greater inequality. This Gini coefficient is transformed into a Gini index by multiplying by a factor of 100. Table 1 presents this indicator for a number of countries, against which the high level of inequality of Costa Rica, which exceeds Mexico, United States and Spain, can be seen.

Table 1: The Gini coefficient for selected countries

Country	Year surveyed	Index
South Africa[b]	2000	57.8
Brazil[a]	2004	57.0
Costa Rica[a]	2003	49.8
Mexico[b]	2004	46.1
EEUU[a]	2000	40.8
Spain[a]	2000	34.7

[a]Data refer to income distribution by percentiles of the population, ordered by per capita income.
[b]Data refer to expenditure distribution by percentiles of the population, ordered by per capita expenditure.
Source: United Nations Program for Development, Human Development Report 2007-2008.

According to data from the Multi-purpose Household Survey (National Institute of Statistics and Census, 2008), 5.61% of males and 6.83% of females participate in higher education in Costa Rica. In terms of the average participation rate for the years 2003, 2005 and 2006, the State of Education reports that 78% of students in higher education came from the top two income quintiles (State of the Union Programme, 2008). Another important aspect of access to higher education, the report says, is that in terms of the level of education in a typical household, "about 40% of the students come from households whose heads also have university education" (p. 94). With regard to this issue of representativity of the Costa Rican population at the University of Costa Rica (UCR), Figure 1 and Table 2 below present data. These data examine the relationship between the relative participation of students at the UCR and the Social Development District Index of the school of origin of those students. The Social Development Index (IDS), calculated by the Costa Rican Ministry of Planning

(MIDEPLAN) is a summary index [which] is constructed from a set of socioeconomic indicators (MIDEPLAN, 2007) that incorporate four dimensions: economic, social, health and education development. These dimensions are calculated at the district level, with the geographical districts and administrative units subdivided into cantons or municipalities. Analysed below are the percentage of population between 17 and 24 who were admitted to the UCR in 2009 by the district of origin of the school and by the value of the IDS.

Figure 1. Percentage of students who were admitted to the University of Costa Rica by district of origin (IDS) for the year 2009

Source: Based on Population Projections of the Central American Population Centre of the University of Costa Rica and data provided by the Office of the Registrar of the UCR.

Table 2: Proportion of people per 10 000 aged between 17 and 24 years admitted to the UCR by Social Development Index (IDS) rank in 2009

Category	Target population (per 10 000) admitted to the UCR
Districts with IDS less than or equal to 50%	55,14
Districts with IDS greater than 50%	126,72
Districts with IDS less than or equal to 30%	32,76
Districts with IDS greater than or equal to 70%	118,46
Number of districts with IDS less than or equal to 30 = 17 Number of districts with IDS greater than or equal to 70 = 194 Total number of districts = 463 Source: Based on data supplied by the Registry Office of the UCR and Population Projections of the Central American Population Centre.	

These data suggest the need for and relevance of a programme aimed at improving the levels of representativity of the national population at the UCR, as it is clear that the participation rate of the national population aged between 17 and 24 at the University of Costa Rica differs greatly depending on the level of social development of the various districts. For example, there is a clear disparity in terms of representativity at the UCR for young people who reside in districts with lower social development indices. It is estimated that a person aged between 17 and 24 years from a district with an IDS of greater than 70% has a probability of enrolling at the UCR that is almost four times (3.61) higher than is the probability associated with a person who comes from a district with an IDS that is lower than 30%.

2. The Approaches

Given the imperative to ensure that the student population in higher education better represents the diversity of the general population in each country and to identify more precisely students from educationally disadvantaged backgrounds with the intellectual potential for higher education study, both the University of Costa Rica and the University of Cape Town have generated approaches that attempt to balance the needs for excellence with the needs for equity. Both approaches are also characterised by the imperative to tackle this challenge scientifically. Whilst the project at the University of Costa Rica (UCR) is a newly-created project and is still in its initial phase, researchers at the University of Cape Town (UCT) have been developing and applying these approaches for over 20 years as part of a programme of alternative admissions research. Both initiatives seek to contribute effectively to improving the representativity of various subgroups of the population at their universities, thereby assisting in the process of national development both in terms of equity of income and permanent employment. The goal is to identify those students who have had little or no historical contact with the academy and who have – by reason of their socio-economic or socio-cultural backgrounds – often not even contemplated higher education as a possibility in their lives. These are the target populations for these projects. What follows is a description of these approaches.

2.1 South Africa: The Alternative Admissions Research Project at the University of Cape Town

In South Africa, the University of Cape Town's Alternative Admissions Research Project, whose current co-ordinator is Dr Alan Cliff, has over 20 years' experience with the development and implementation of an alternative admissions assessment programme for educationally disadvantaged students. This university has adopted a rather novel approach of focusing not only on the 'psychometric purity' of tests, but also on their educational purposes. As such, they have taken as reference point the work of Vygotsky (1978) and his concepts of ZPD and 'scaffolding' to develop tests that simultaneously serve educational, selection and diagnostic purposes. The fundamental model underlying this approach is that of dynamic assessment (Sternberg and Grigorenko, 2002).

The project currently develops tests in three domains: Academic Literacy, Scientific Reasoning and Mathematics Comprehension. These assessments embody the principle that 'teaching' of more complex concepts is incorporated in the design of the test. In addition, tasks that the student must perform in the test are authentic in the sense that they simulate as far as possible the kinds of academic contexts and tasks that will be demanded of students in higher education. Another feature of these tests is that they assess test-takers' reading ability in this case in English or Afrikaans, because these are the media of instruction in higher education in South Africa. As teaching tools with diagnostic features, the tests incorporate desired pedagogic approaches and 'simulate' the academic demands that will be faced by students. These design features make these tests particularly attractive in terms of their potential added value, especially in the case of students from educationally disadvantaged backgrounds.

The main strategic aim of the Alternative Admissions Research Project (AARP) has been directed towards the development of tests of academic literacy and mathematical and scientific reasoning (Cliff and Hanslo, 2005, Cliff and Yeld, 2008) that focus on the identification by alternative means than the school-leaving examination of educationally disadvantaged background students who have the potential to succeed at UCT, provided that the academic support and curricula structures meet the learning needs of these students. Within a dynamic testing framework (Sternberg and Grigorenko, 2002), the project aims to develop tests which are valid predictors of performance in educational contexts, particularly for students from educationally disadvantaged backgrounds.

The project's objectives can be summarised as:

- Identifying, in particular, academically talented students but educationally disadvantaged students whose education may not have allowed them to demonstrate their true talent.
- Ensuring that students with demonstrable potential, in terms of their results on tests, also receive academic and other forms of support (such as financial aid, residence places, social and psychological support, and so on).
- Contributing to the diagnosis of the academic strengths and weaknesses of all first-time entering students at UCT, and the design and development of support mechanisms for teaching, learning and curriculum development.

2.1.1 Description of the AARP tests

The Academic Literacy test or PTEEP (its acronym in English) (Cliff, 2002, Cliff, Yeld and Hanslo, 2003) aims to assess the ability of students to cope with the following: understand the overall meaning of texts they are likely to encounter in their studies; understand the meaning of words and phrases in context; identify and track academic argument; understand and evaluate the evidential basis of reasoning; extrapolate and draw conclusions from evidence that is stated or given; identify main from supporting ideas in the overall organisation of text; understand information presented visually (for example, graphs, tables, and so on); and understand basic numerical concepts and information used in text, including the ability to do basic numerical manipulation.

The Mathematics Comprehension Test (MCOM) is designed to provide information about a student's potential to learn new mathematical skills and concepts. It is designed according to dynamic testing principles (Sternberg and Grigorenko, 2002). The following criteria are incorporated into its design:

- topics typically not included in secondary curricula are chosen so that students who have had a poor secondary education experience are not further disadvantaged;
- test themes incorporate a variety of facts, skills, concepts and principles that can be evaluated at a range of cognitive levels;
- text is used as teaching medium;
- topics minimise the need for mathematics skills acquired through formal education, so that candidates who come from environments with fewer educational opportunities are not further disadvantaged;
- questions are carefully sequenced according to their degree of complexity;
- the language used in the test is accessible enough so as not to be a disadvantage for students for whom English may be a second or third language.

The Scientific Reasoning Test (SRT): This newly developed test - first used in 2003 – evaluates the capacity of students to cope with the logical reasoning typically required of higher education students. The Science Reasoning Test assesses the ability of students to identify appropriate evidence to support a claim or argument; critique the underlying assumptions and thinking in an argument; understand the nature of speculation and hypothetical reasoning; see logical relationships between phenomena; and understand the concept of 'chance'.

The AARP tests have contributed to equity of access in ensuring that talented students who come from educationally disadvantaged backgrounds are given the opportunity to demonstrate their potential for higher education study, even if their results in the school-leaving examination are not necessarily an accurate reflection of that potential. The development of these tests has assisted in identifying a student's academic potential on dimensions, such as verbal reasoning, numeracy and mathematical and generic scientific reasoning, required of an entry-level student in the particular context of higher education teaching and learning.

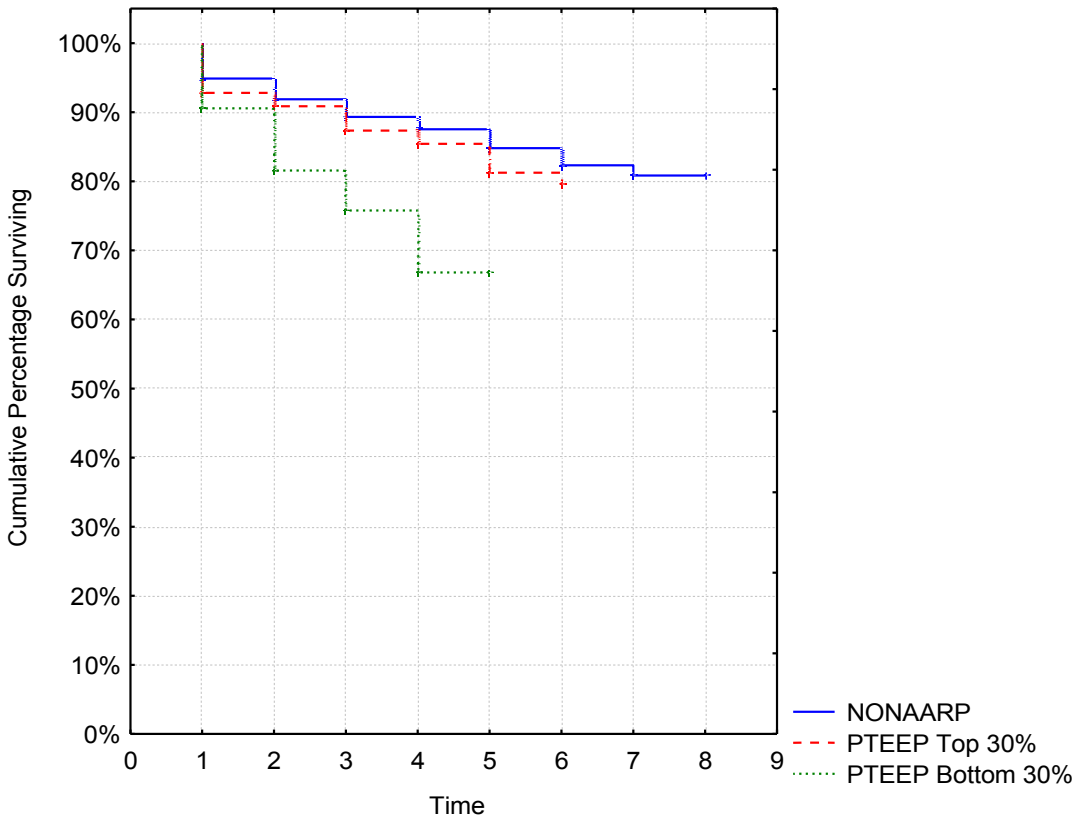
The notion of the construct of Academic Literacy first articulated by the AARP and, in particular, through the work of Associate Professor Nan Yeld (Yeld, Cliff and Hanslo, 2002), in collaboration with members of the Language Development Programme

located in Academic Development at UCT, represents a substantive contribution to higher education in South Africa, a contribution that has gained credence nationally and that is generating increasing attention internationally. The contextualisation and interpretation of evidence regarding the educational and demographic backgrounds of students represent another powerful contribution by the AARP towards the identification of educational talent in South Africa. Research from AARP tests have helped reduce the chances that talented students with fewer or impoverished educational opportunities are 'lost' as a result of having to compete on uneven terms with students from well-resourced educational backgrounds (Cliff, Ramaboa and Pearce, 2007). For all students who aspire to enter higher education, AARP tests have helped the sector to understand the levels of preparedness of such students in crucial areas such as generic scientific reasoning, mathematics and language.

Over a number of years, predictive studies have explored associations between the performance of students on the AARP tests and their subsequent academic performance (see for example Cliff and Yeld, 2008). By using statistical methods such as survival analyses, these tests have been shown to be associated with the prediction of the likelihood of successful progression for students through their academic studies. Figures 2 and 3 show the graphs of the survival functions for students from educationally advantaged and educationally disadvantaged backgrounds respectively. At the level of an individual student, these estimates provided by the AARP also make it possible to calculate the degree of 'risk' attached to the academic performance for a particular student in a test, and can be attached to recommendations regarding the provision of curriculum that might be required to reduce that risk.

This first figure shows the time to academic exclusion for students from well-resourced school backgrounds.

Figure 2. Survival function for different groups of well-resourced educational background students on the academic literacy test (PTEEP in English)



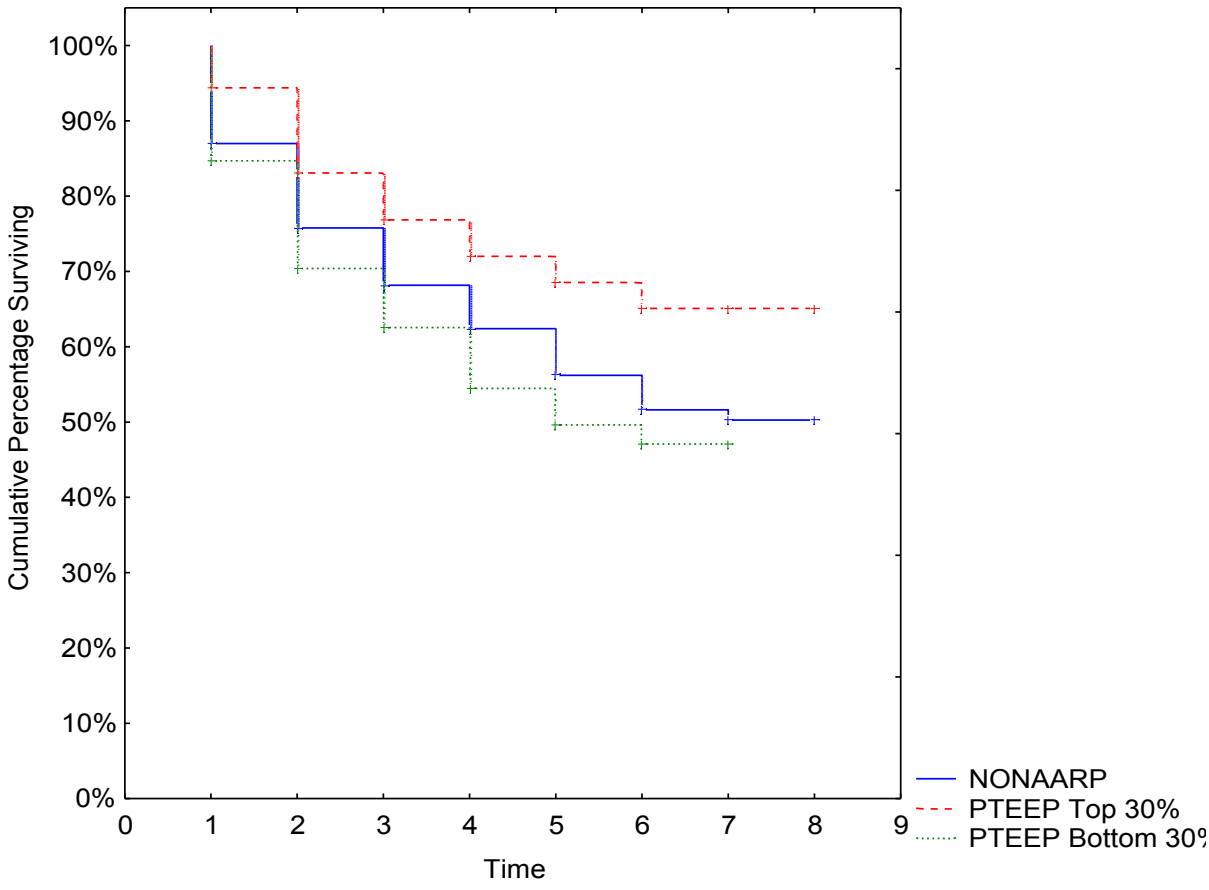
Notes:

(1) Time is given in years.

(2) "Non-AARP" refers to students who entered the university without taking an alternative admissions test; "PTEEP Top 30%" refers to students from educationally well-resourced backgrounds who scored in the top three deciles of the distribution of scores in the group on the academic literacy test; "PTEEP Bottom 30%" refers to students from educationally well-resourced backgrounds who scored in the bottom three deciles of the distribution of scores in the group on the academic literacy test.

The following figure shows a somewhat different pattern for students who came from backgrounds with scarce educational resources.

Figure 3. Survival functions for different groups of poorly-resourced educational background students on the academic literacy test (PTEEP in English)



What the two figures above appear to show is that, for students who come from educationally disadvantaged backgrounds, good Academic Literacy test performance is better associated with academic progress than is poor performance on this same test or performance in the school-leaving examination. The implication is that good performance in this test is a more reliable assessment than is the school-leaving

examination in terms of the likelihood of academic progression for students from educationally disadvantaged backgrounds. These survival analyses have been replicated twice more and the patterns shown for the Academic Literacy test are similar to those produced for the Mathematics Comprehension test. There is clear benefit for talented students whose potential can be more accurately identified on the basis of AARP test performance. AARP assessment makes a contribution to widening access, particularly for students from educationally disadvantaged backgrounds, but arguably also for students from more "traditional" or middle class educational backgrounds.

2.2 Costa Rica: The Specific Abilities Testing Project

The University of Costa Rica, in its Constitution (1974), states its purpose as, "to achieve transformation, society needs to achieve the common good through a policy aimed at achieving true social justice and integrated development, towards full freedom and full independence of our people." (Article 3, Constitution).

According to the admissions model established by the University of Costa Rica (UCR), the purpose of entry-level testing is for the university to assess the academic potential of students for higher education. As the oldest and most prestigious public university in the country, the UCR continually experiences pressure from different sectors of society around dimensions of excellence and equity in its admissions processes. In turn, there are ongoing concerns in the institution around addressing widening economic and social inequalities and improving the representativity of various categories of student population, thereby optimally contributing to the goals of integration and social mobility that are part of its mission.

In this context, there is justification for research approaches for the design of admissions models and instruments that incorporate equity together with excellence as one of the basic pillars, without losing sight of the institution's scientific character. Meeting this current challenge is essential in order that the university can effectively contribute to the processes of mobility and social integration that are part of its core mission. In the context of these equity and integration policies and social mobility, approaches are sought that develop measurement-based instruments with high rates of reliability and validity, instruments that are influenced as little as possible by the socio-cultural context of the student, that enable the university to identify students with academic potential who might not have had optimal educational opportunities.

It is considered vital to validate these measurement instruments in order to prove scientifically that differences in opportunity can be minimised in order to more closely achieve the measurement of academic potential as the key construct. Students could possess potential, but the presence of educational disadvantage may mean this potential is 'lost' if traditional measuring instruments are used.

Thus, it is important for the institution to assist these students and provide them with the capacity to make a difference in their families and in their communities, according to the Constitution, which states: "... Achieve excellence in the training of professionals, who in turn act as diffusers and change agents in the community at large." As successful students, these students will be an example to other young people who intend to target access to higher education. It should be noted that these students not only need

economic support, but must be assured of comprehensive support to enable them to persist in higher education and, finally, graduate.

Concomitant comprehensive support must exist for students to enable them to manage successfully through the processes of adaptation to college. Although financial support is essential, it is not sufficient. Mentors are needed to support these students and help them address their shortcomings in terms of formal knowledge (study skills, presentation of work, basic research techniques, navigation and use of the resources of the University, and so on) so that they avoid frustrations and possible drop out.

The Specific Testing Project of the Institute for Psychological Research of the University of Costa Rica (Montero, 2009) was conceived in 2005 in response to an agreement dating back to the University Council of 2003. Since its inception, the project has been enriched by the contributions of the community university, including the different levels of governance, the University Council, the Institute for Psychological Research and the academic units themselves.

To the initial objectives, which referred to the development and validation of instruments for the selection of students for specific careers, were added two others. One of these related to the additional need to incorporate a diagnostic purpose for tests, allowing the student (and the university) to make a qualitative assessment of their own performance. Accordingly, there was a need for tests to provide not only a numerical score, but a description of the student's strengths and their areas of development in terms of the content measured in the tests. This same diagnostic information is also relevant to the institution, both as applied to the entire population of applicants and when the relative performances of various categories of applicant (e.g. students from public schools and private schools) are compared. This information allows the institution a more detailed description of the skills and knowledge present in the population of candidates applying for various career options.

The other main objective which has been added to the project, as a result of recommendations by the community university, is related to the principle of equity. On one hand, the tests referred to earlier in the discussion on scientific viability should help reduce opportunity gaps in education between different population groups, in order to be able to identify potential in the academic environments of young people from economically, socially and culturally disadvantaged backgrounds. It is also recognised, however, that to create a successful balance in both dimensions (excellence and equity), there is need not only to build instruments and diagnostic screening to measure academic potential, but also to design programmes that are complementary to the regular admissions process that offer educational options for students with academic potential who come from educationally disadvantaged environments. Thus, equity together with excellence was included as one of the cornerstones of the project.

These two objectives of the Specific Testing Project can be summarised as follows: (1) ensure that the tests serve a diagnostic function, allowing the student and the university to make a qualitative assessment of performance and (2) contribute to the processes of social mobility and integration which are part of the fundamental mission of the university to develop strategies and tools to identify students with academic potential who have had fewer prior educational opportunities. Among the desired impacts of the

project in the medium term, is a decrease in the percentages of student attrition and improvements in academic performance and promotion.

The theoretical frameworks for this research are located in cognitive psychology and psychometrics (Nunnally, 1991; De Juan Espinoza, 1997; Bond and Fox, 2001; Martinez, 2005; Sternberg and Pretz, 2005; Montero, 2001; Montero, 2008a). Although these two frameworks traditionally have developed separately, in the context of the present approaches possibilities arise for integration (Embretson and Gorin, 2001; Junker and Sijtsma, 2001; Cortada Kohan, 2003; Leighton and Gierl, 2007). In the UCR case, it is believed that this integrated approach will contribute substantially to the process of providing increasingly detailed and precise diagnostic interpretations. The purpose of the project is to study, analyse and empirically test different hypotheses about the cognitive processes involved in solving test items in order to identify item characteristics that predict levels of item difficulty.

The predictive validity analysis, as mentioned earlier, is also essential if these tests are to be used as screening tools for various academic fields and careers. Predictive validity here seeks to establish the degree of association between a test score and an appropriate measure of academic performance. Predictive validity implies that higher test scores are associated with higher levels of academic performance. Regression and structural equation models are currently used to estimate the predictive validity of the instruments. To date, the project has established and collected various evidence of validity for three tests: Written Expression (EE), Quantitative Skills (HC), and Reasoning with Figures (PRF). In addition, an operational implementation target population for diagnostic purposes was identified in October 2008.

The Quantitative Skills Test (HC) measures reasoning based on mathematical relationships and properties. The reasoning processes can be inductive, deductive or a combination of the two. Assessment is in four content areas: Geometry, Algebra, Arithmetic and Data Analysis, and Probability. This test is of importance for those careers which require the use of mathematics as a foundation. The test consists of multiple-choice items and the use of the calculator is not permitted. The knowledge required to solve the items does not go beyond the content of the official school curriculum of the ninth year. The test duration is one hour and forty-five minutes.

The Test of Reasoning with Figures (PRF) measures general reasoning skills presented in novel tasks using a series of geometric figures or lines to identify rules for classification and completion, and complete series arrays and sequences of events. The test duration is about 40 minutes. The test is designed to measure the construct called fluid intelligence (Cattell, 1971). This construct involves basic processes of reasoning and related cognitive activity, to a lesser extent, the use of school knowledge, educational opportunities and culture.

The creation of the PRF caters precisely to the equity dimension, a fundamental concern at the University of Costa Rica, as it seeks to measure more precisely the learning potential of students. Its use could help to identify young people with academic potential, who have had fewer educational opportunities and who come from economically and socially disadvantaged backgrounds. The use of this test as part of the selection process for admission to the university may also provide scientific justification for the use of scores from other tests based on the assessment of fluid intelligence and

thus not exclude young people who have potential but have had fewer opportunities to learn. It is recognised that there may be people that have similar potential to learn and pursue higher education careers successfully, but have had very different educational opportunities. The implementation of this kind of approach also involves a significant investment in university courses or activities called 'levelling' or 'preparation'.

Fluid intelligence can be defined as an effective neuronal energy flowing through various mental activities. It involves basic processes of reasoning and intellectual activities which depend, to a lesser extent, on learning and culture, that is, they rely less on formal education and are more dependent on physiological influences. Examples of this construct include inductive and deductive reasoning and other skills associated with the ability to solve novel problems and create new concepts (De Juan Espinoza, 1997; Carroll, 1993). Known measures of fluid intelligence are Raven's Progressive Matrices test and Cattell's g Factor test. These tests are specifically designed to minimise the impact of acquired knowledge, including language ability (Cattell and Cattell, 2001).

The concept of crystallised intelligence, on the other hand, refers to mental processes that reflect not only fluid intelligence operations, but also the effects of the environment (experience, learning and culture). Reading comprehension and vocabulary knowledge have strong crystallised intelligence dimensions; as do traditional tests or academic achievement. Thus, crystallised intelligence is related to the extent and depth of knowledge of language, knowledge about the information and concepts of a culture, and declarative knowledge. It is acquired through education and experience (Carroll, 1993; Juan Espinoza, 1997; Kvist and Gustafsson, 2007). Factors such as motivation and personality as well as educational and cultural opportunities are key to its development.

It goes almost without saying that the fluid-crystallised distinction is not a dichotomy but rather a continuum, and, in general, different empirical measures of intellectual skills and knowledge are located at different points on this continuum (Plucker, 2003). The fundamental assumption underlying the project is that specific testing by means of the PRF may more accurately identify for higher education students with academic potential from educationally disadvantaged environments. Accordingly, in the context of this framework, it is possible to predict that differences in fluid intelligence measures will be smaller than differences in measurements of more crystallised aspects of intelligence when socioeconomic and cultural groups that differ on average in terms of their educational opportunities are compared.

Currently there are two sets of empirical evidence supporting the basic assumptions underlying the construct measured in the PRF, within the model of fluid and crystallised intelligence Cattell (1971). According to this model, differences between population groups which differ in terms of their access to educational opportunities ought to be lower on a measure of fluid intelligence measurement than on a measure of crystallised intelligence.

The first evidence is provided by the operational implementation of an early version of the PRF (Test of Reasoning with Figures) conducted in October 2008 with secondary school students who sought to study in one of nine faculties. The Test of Written Expression (EE), a single-answer ("multiple-choice") format test that measures correct language use in normative terms, was also implemented.

Since the latter is clearly an example of a knowledge-loaded (crystallised intelligence) test, the hypothesis was that the differences between students from public and private schools should be smaller on the fluid intelligence test (PRF). The findings confirmed this hypothesis, since the differences on standardised measures using the "student's t" test, effectively showed values substantially smaller in the case of the PRF. These results are shown in Table 3.

Table 3. Results obtained for a sample of students applying to nine faculties. Fluid intelligence (PRF) and crystallised intelligence (EE) tests. Comparison by school type. Specific Testing Project. University of Costa Rica. 2008

	Sample size		**Average (Rasch score)***		**Standard Deviation (Rasch score)***		**Student's 't' test score****
	Private	**Public**	**Private**	**Public**	**Private**	**Public**	
Test of Fluid Intelligence (PRF)	447	1054	0,68	0,29	0,71	0,78	-9,03
Test of writing ability (EE)	354	867	1,10	0,49	0,90	0,78	-11,81
*A Rasch score of zero represents a test item of average difficulty **A Student's t test for equal variances was used because the Levene test for equality of variances was not significant							

Further evidence to support the basic assumptions underlying the measurement of the construct in the PRF is given by the results of a recent study of students in 13 Costa Rican secondary schools (Castelain, 2009; Morales and Fallas, 2009). A random but non-proportional sample was selected, which deliberately over-represented schools in regions of lower social development from five areas of Costa Rica: the central zone (which is more developed), and the northern, southern, Caribbean and Pacific zones. Students in the tenth school year in each case were given two tests, the PRF and the writing test referred to earlier, with its strong crystallised intelligence components. The hypothesis was again that differences between students in public and private schools, and by social development areas, should be lower on the PRF.

Tables 4 and 5 below show the results. Table 4 confirms the hypothesis with the Student's t test score for the Writing test being almost double that of the score for the PRF when the public and private schools are compared (Castelain, 2009; Morales and Fallas, 2009). Similarly Table 5 shows that, while difference levels in the PRF sample cannot be statistically generalised to the total population in the case of the Writing test, differences do occur in statistically generalisable comparisons, conforming with three groups of averages, and again providing evidence for the underlying hypothesis even though the sample is small and reduced in statistical power.

Table 4. Results obtained for a sample of tenth year Costa Rican secondary students on a Fluid Intelligence (PRF) and Crystallised Intelligence (EE) Test. Comparison by school type. Specific Testing Project. University of Costa Rica. 2009

	Sample size		Average (% Correct)		Standard Deviation (% Correct)*		Student's 't' test score*
	Private	Public	Private	Public	Private	Public	
Test of Fluid Intelligence (PRF)	100	197	55,38	48,28	12,70	13,36	-4,41
Test of writing ability (EE)	134	220	55,48	44,62	12,88	11,53	-8,22
*A Student's t test for equal variances was used because the Levene test for equality of variances was not significant.							

Table 5. Results obtained for a sample of tenth year Costa Rican secondary students on tests of Fluid and Crystallised Intelligence. Homogeneous sets averaged according to an SNK test Comparison by regions of development Specific Testing Project University of Costa Rica. 2009

	EE Test (Crystallised Intelligence)			PRF Test (Fluid Intelligence)	
	n	Group 1 (% Correct)	Group 2 (% Correct)	n	Group 1 (% Correct)
South	113	44,5401		111	47,98
Pacific	72	46,9444	46,9444	72	49,25
Central	23		51,2253	23	56,18
North	70		52,0519	21	53,33
Caribbean	78		52,4709	70	54,82
Significance		,330	,114		,53

These results are encouraging and indicate the need to continue working in this direction, in order to respond to the challenge of maximising scientific excellence and equity in admissions in higher education.

In conclusion it is important to reiterate that the two approaches, in Costa Rica and in South Africa, although starting from different frameworks and mindful of the characteristics of their respective contexts, both try to address the issue of fairness in admission to higher education from a scientific and not only a political perspective. We believe that this is the added value of both approaches. This paper is not intended to be a comparative analysis in order to conclude which of the two approaches is more valid, but seeks to illustrate two possible research-based approaches to dealing with the difficult challenge of excellence and maximising equity in higher education admissions.

Each proposal has generated and continues to generate diverse evidence of its value and its constraints.

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