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The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn.

(Alvin Toffler)

HIGHLIGHTS

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INSIDE THIS ISSUE

Low cost private schools as part of the solution for education for all

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Abstract

Empirical research in Asia, Africa and Latin America strongly suggests that low cost private schools are part of the solution and definitely not part of the problem in global efforts to provide quality education for all. Education bureaucrats may be right to point out that there are still problems with access and equity, as well as the quality of provision. Yet, compared to public sector schools, low costs private school seem to address the needs of the poor more effectively and exceed in performance by almost every measure. Even though the problems associated with low-cost private schools are real they are not insurmountable. This article discusses various policy instruments that helped to increase the incentives of low-cost private schools to improve teaching quality, student performance, responsiveness to local needs and reputation in the private sector and academia.

Introduction

An education revolution is sweeping the developing world. In the slums and shanty towns of Asia and Africa poor people are abandoning public (government) schools. They're appalled by their low standards. Instead, they're sending their children to low cost private schools. The existence of these schools is becoming increasingly recognized. However, this development is not greeted with universal enthusiasm by development agencies and governments. For instance, the latest "Education for All" (EFA) Global Monitoring Report 2009 (UNESCO 2008) has a special section on low cost private schools. But rather than seeing the growth of the schools as recognition of the way the poor can respond to challenges, the stress is on their rise as a "symptom of state failure" [1]. The report does acknowledge the ubiquity of these low cost private schools: 'Even a cursory observation of education provision in slums from Hyderabad to Nairobi demonstrates that private provision in some developing countries is no longer the sole preserve of the rich. Private primary schools charging modest fees and operating as small businesses, often with neither regulation nor support from government, are changing the education landscape … a growing marketplace in education provision is appearing by default" [2]. However, "Unplanned growth in private schooling for the poor in some parts of the world is symptomatic of an underlying malaise: underperformance, or outright failure, of public providers" [3].

Why is the emergence of these low cost private schools - set up and run by entrepreneurs from the poor communities themselves – seen as second-rate to the more desirable option of having "a publicly financed and operated education system that offers the option of good-quality, free education to all citizens"? [4] There are two main reasons given in the report:

First, quality: the report agrees that much of the research shows that "children enrolled in low-fee private schools perform better, on average, than those in government schools, once adjustments are made for socio-economic status and other variables' [5]. However, they note that some government schools might do better than private schools, and, most significantly, 'The only reason the private schools look so good is that the poorly performing public schools are so disastrous' [6]. In other words, the private schools may be better than the government schools, but they are still of very low quality. Moreover, many of the poor don't have access to government schools at all – so to speak of their *choice* of private school is a misplaced description of what is actually the case. In Kenya, for instance, there are no government schools in the slums. There may be government schools on the periphery of the slums, but these require official residency titles for enrolment. Most slum dwellers lack "legal property status", so "their children are excluded." [7]. And household surveys reveal parents complaining about the quality of the low cost private schools, "with staff shortages, congested classrooms and lack of teaching materials identified as common problems" [8].

The second major objection concerns access and equity. While it is acknowledged that the fees charged in the low-

cost private schools are very low, once other costs of schooling, such as uniform, books and transport, are added, then the cost becomes quite prohibitive for many of the poor. For instance, one study from rural Uttar Pradesh, India, "puts the total cost of educating four children (the average family size) in a low-fee school at half the mean annual salary for households in the lowest two income quintiles" [9]. Moreover, this means that some families have to make choices about use of scarce resources, and so, the report says, tend to choose their male children to go to private schools, leading to increased gender inequity.

These two issues, concerning low quality and difficulties with access and equity, are serious problems. But is the only solution to view the low cost private schools as an irrelevancy to the solution of education for all, or is there a possibility of incorporating the private schools into the solution? We'll discuss this possibility below. But first, while the existence of the low cost private sector is being more widely recognized, it still may be unfamiliar to some readers. The next section gives some colour by outlining findings of the research that me and my teams have been conducting over the last few years.

1. The phenomenon of low-fee private schools

My recent research, funded by the John Templeton Foundation, investigated selected, officially designated 'poor' areas of Nigeria, Ghana, Kenya, India and China. Research teams explored informal settlements – slums and shanty towns – in metropolitan cities in these countries, and poor areas in the rural hinterlands surrounding these cities ("peri-urban"). They researched remote villages in impoverished north-west China, and rural communities in south India. The teams combed these poor areas, going down every alleyway in the slums, visiting every settlement in the rural areas, asking people on market stalls and in the streets, to find where the poor were being educated. They found large numbers of schools – 918 in the 'notified' slums of three zones of Hyderabad, India, for instance. And when they found schools, public or private, they interviewed school managers, and visited, unannounced, primary classrooms to assess the activity of the teacher, and to look for selected school inputs. The researchers tested around 24,000 children, taken from a stratified random sample of schools within these poor communities. Children were tested in key curriculum subjects, and questionnaires given to children, their parents, teachers and school managers, and IQ tests to children and their teachers, to elicit data to control for a wide range of background variables, including peer-group variables.

What the research teams found points to an educational revolution that is taking place. In the poor urban and peri-urban areas surveyed, the *vast majority* of school children were found to be in 'budget' private schools. For instance, in the poor urban and peri-urban areas of Lagos State, Nigeria, 75 percent of schoolchildren were in private schools. In the peri-urban district of Ga, Ghana, the figure was 64 percent, while in the slums of Hyderabad, India, 65 percent of schoolchildren were in private unaided schools. These budget private schools are usually established by entrepreneurs from within the poor communities themselves, employing teachers from those communities – unlike in government schools, where teachers are often brought in from outside. The private schools charge very low fees. For example, in Hyderabad, mean monthly fees at 4th grade were Rs. 78.17 ($1.74) in unrecognized and Rs. 102.55 ($2.28) in recognized private schools in the slums – about 4.2 percent and 5.5 percent respectively of the monthly wage for a breadwinner on a typical minimum wage of about Rs. 78/- per day.

Private schools for the poor are not just an urban or peri-urban phenomenon, either. In the deprived district of Mahbubnagar, rural Andhra Pradesh, India, roughly half of all schoolchildren were in private unaided schools. In the remote villages of rural Gansu, China, official figures showed no private schools at all; but we found 586, serving 59,958 children. [10]

What of the quality of the provision vis-a-vis government schools? In every setting, teacher absenteeism was lower and teacher commitment – the proportion of teachers actually teaching when our researchers called unannounced – higher, in the private schools for the poor than in government schools. Only on *one* input – the provision of playgrounds – were government schools superior to private schools across the range of studies. *On all other inputs,* such as provision of drinking water, toilets, desks, chairs, electric fans and lighting, tape recorders for learning purposes and libraries, private schools for the poor were superior to government schools.

Importantly, the research showed that the private schools everywhere were outperforming the government schools in the key curriculum subjects – even after controlling for

background variables. In Lagos State, for instance, the mean math score advantage over government schools was about 14 and 19 percentage points respectively in private registered and unregistered schools, while in English it was 22 and 29 percentage points. And after controlling for background variables, and, given that students were not randomly assigned to the different school management types, the school choice process, we found these differences, although reduced, were still largely in favor of private education. In Lagos State, Nigeria, the predicted score in mathematics was 45.1 percent for an average sample child in government school, 53.5 percent for the same average child in an unregistered and 57.6 percent in a registered private school. For English the predicted score for an average sample child in government school was also 45.1 percent, while there was no significant difference between attainment in both types of private school – predicted score for the same child was 64.4 percent.

Significantly, private schools were found to be outperforming government schools for a fraction of the teacher costs – likely to be the largest part of recurrent expenditure in schools. Even when the per pupil teacher cost was computed (to take into account the fact that class sizes were largest in government schools), private schools came out less expensive: In the government schools in Lagos State, for instance, per pupil teacher costs were nearly two and a half times higher in government than in private schools.

2 Further developments – accepting the challenges

The research summarized in the previous section might suggest a rather optimistic view of the role that the low cost private sector could play in education for all. But the first section suggested this wasn't the position taken in the major UNESCO report. In my view, for what it's worth, the criticisms raised there are worth taking seriously. But instead of pointing to the need to look beyond the low cost private schools, I believe they signal the possibility of incorporating the low cost private education sector as part of the strategy to bring "education for all".

First, what about the issues of access and equity? Are these irrevocable problems for a solution involving the low cost private sector? The Education for All report itself seems to deny this by observing increased funding of scholarships or vouchers in order to facilitate better access to low cost private schools . Curiously, rather than seeing this as a possible solution, however, the report notes that this represents a 'questionable public-private partnership', at least given their examples from Pakistan. Here there are two policy innovations: an 'education voucher programme for selected slums', where 'parents can use state funding for entry to low-fee private schools'[11], and the "Foundation Assisted Schools programme", which "provides a per-child subsidy for children enrolled directly in private schools in selected high-priority areas" [12]. So what is the problem with these ways of extending access to schools which the report agrees are in general of higher quality than the government schools which parents are permitted to leave? The report notes that "While there is some initial evidence of positive influence on enrolment and learning outcomes, serious problems have been identified". These problems are three-fold. First, that there is "inequality of financing" [13], particularly with regard to some provinces which are better able to raise the necessary external funds. This hardly seems to be a particularly large problem: if some provinces are finding it harder to raise funding, then a way forward would be to assist those provinces. The second problem is "*Financial sustainability*": " Public-private partnership models have been an important component of education-sector World Bank loans in Punjab and Sindh. Their continuation and expansion is contingent on sustained donor support, as the Ministry of Education has so far not decided to mainstream the models. That support cannot be taken for granted" [14]. Again, this hardly seems a reason to damn the model. Instead, if it seemed like a worthwhile way forward, we could seek to enhance the support.

Finally, the problem is "*Limited scope":* "Notwithstanding the international attention Pakistan's public-private partnership programme is receiving as a potential model for other countries to follow, the school voucher programme reaches only 10,000 students and the Foundation Assisted Schools programme only 50,000." These are only drops in the ocean compared to the numbers of children (2.7 million boys and 4.1 million girls) out of school [15]. But again, if this is the problem, why not seek to extend the programmes? Perhaps finding the finance to do so would be a problem? I don't think this is true. I once suggested elsewhere that, with reasonable assumptions about the overheads required for such a scheme, and focusing on Ghana as an example, 'the education aid budget for Ghana from DfID [Department for International Develop-

ment, the British government aid agency] alone would provide all the funds for targeted vouchers for those currently out of school to attend [low cost] private schools' [16]. This is possible of course because of the low fees charged by these private schools. So I indicated 'Add in the education aid budgets for Ghana from the US Agency for International Development, Oxfam, the Nordic countries, Germany, the Netherlands, and so forth, and it soon becomes clear that children currently in government schools could also attend private school' [17]. Similar calculations could be made for Pakistan too. And of course, if access for girls is a particular problem, (which our surveys in India suggested it may be, although in Africa it was not) then the solution could lie in targeted vouchers for girls.

Instead of embracing an alternative that could lead to children attending higher quality schools than the government ones currently on offer, the Education for All report (UNESCO 2008) is oddly putting forward objections which don't seem substantial at all. On the contrary, it would seem that the problem of access and equity could be addressed within a low cost private school system, if there was political will to do so.

But perhaps the access and equity objections are not the most substantial ones, and the issue of low quality is the motivation for not seeing the low cost private schools as part of the solution? Let's turn to this quality issue. At the moment, the Education for All report – and I would concur – seems to suggest that poor parents are currently faced with three options: They can send their children to a (free) government school, a low cost private school, or not to school at all. The discussion above suggests that perhaps with targeted vouchers, these three options could become one, the second option. However, the Education for All report suggests that it's not particularly desirable because while the quality might be better than in government schools, it's still very low. I think there's something in this. What I want to see is parents having a fourth, better option– to send their children to a *higher-quality*, low-cost private school. This turns out to coincide with the desire of many entrepreneurs who run low cost private schools, and with parents too, as indicated in the comments above from parents in Kenya who were not satisfied with the quality of the available private schools.

I've been working on precisely this challenge. Three years ago, with the publication of the IFC/FT prize-winning essay 'Educating Amaretch' [18]. I started advocating two major ways forward: creating loan schemes to help low cost private schools improve; and creating brand-name chains of low cost private schools. It's perhaps obvious why the first can help schools improve quality: access to capital is difficult for low cost private schools, many of which lack proper property rights or are in areas 'black-listed' by banks. But my earlier pilot schemes with "Educare" in India and Nigeria had shown a hunger by school entrepreneurs for loans to improve infrastructure, by building toilets, computer labs or libraries, or extending classrooms, and a willingness to pay back these loans over a reasonable time period. With this evidence to hand, I had in-depth meetings with Opportunity International, USAID and Gray Matters Capital, and each of these bodies has as a consequence set up loan schemes for low cost private schools. [19]

The second way forward might not seem so obvious. Why would a brand-name chain of low cost private schools help with improvements to quality? There are at least four sets of reasons:

⇒ The information problem – parents are faced with a genuine information problem in the current situation. How can they judge if one school is better than another? How do they know that their current school is genuinely serving their children's needs? A brand name will help parents make judgements in an informed way. Children, too, will prefer a brand-name school, benefiting from improved curriculum, pedagogy, technology and teacher training, and the networks from the larger organisation. As the brand becomes well-known, employers and higher education institutions will trust where children have been educated, giving the pupils an edge for the future.

⇒ Teacher issues – currently in low-cost private schools, teacher retention is an enormous problem. Low quality

of teachers is also perceived as a problem, with many teachers themselves not having qualifications higher than school-leaving examinations. School proprietors, however, may be reluctant to engage in teacher training, having experienced trained teachers leaving for more lucrative employment. Within a brand-name chain of schools, it is assumed that loyalty to the brand, together with the possibility of new career paths through the chain (e.g., as teacher, mentor, trainer, quality inspector, etc.) will encourage teacher retention and hence make viable extensive teacher training.

⇒ Investment in quality improvements and innovation – parents, students and entrepreneurs alike, as well as budget school critics, all agree that quality improvements are desired in the schools, in terms of teacher and management training, curriculum, technology and administration. It is also the case that there may be technological solutions to current educational problems – such as the low level of teacher quality, poor quality of curriculum materials – that could become available if there was R&D in these innovative methods. The required investment in these improvements and innovations could only, or best, arise from the economies of scale inherent in a chain of schools.

⇒ Other economy of scale advantages – improvements in quality offered could also be enhanced in a large scale chain of schools through economies of scale as purchasers of goods and services. For instance, curriculum materials, desks and chairs, hygiene and safety features, and technology could all be purchased much more cheaply within a large scale chain than by standalone schools, enhancing the quality of the educational opportunities presented to the children.

Three years ago, I began advocating that investors and entrepreneurs should set up chains of low cost private schools. Jay Kimmelman came to visit me and my team in Newcastle and then went to Kenya to set up NewGlobe Schools, a low cost chain of schools with finance from Deutsche Bank and Kellogg Foundation. [20] While President of the Education Fund for Orient Global, I helped set up Rumi Schools of Excellence in Hyderabad, India. [21]I've also been involved in the creation of two embryonic chains of schools elsewhere, Sunshine Fortune in China [22] and Omega Schools Franchise Ltd in Ghana [23].

Each of the companies I'm involved in is taking the problems of improving quality very seriously. We're conducting intensive teacher training to help raise teacher quality and developing teacher mentoring programmes. We're devising curriculum materials that can help improve the quality of what is learnt, and we're exploring ways of using and funding computer labs in the schools. It's going to be a very long process, but already we're seeing positive results in terms of learning standards. And something rather interesting is happening: some of the innovations we're trying out in the schools are being imitated in other schools – just as one would predict in markets. [24] Take a very simple innovation (and this has implications for the access section above too, if it highlights one of the reasons why parents can't afford to send their children to private schools): a major problem is the ability of parents to *save* the amount required for their monthly (India) or termly (Africa) fees. If cash is in the house, it can often be used for other immediate things, rather than be kept for school fees. And that's only half the problem: parents have also got to save for school uniform, books, etc. And all this leads to some students dropping out of private schools. So in Omega Schools in Ghana, we instituted a *daily* fee, which included all the funds required for tuition costs, as well as uniform, books, exercise books, as well as transport, food and insurance. This is clearly hugely popular with parents, who no longer have to save but can simply find the funds each day to send with their children. This popularity is seen by other schools, and in the neighbourhood of one of our low cost private schools the innovation has been taken on by 4 other private schools already.

But this brings me to a major reason why I believe going with the low cost private sector might be a better way forward than trying to improve the public sector. The incentives for improvement are in the right direction. When agencies try to improve government provision, there may be success when the agencies are directly involved. However, when they pack up and leave, schools and teachers tend to revert to their preferred methods once the aid missions have moved on. [25] Such projects do not manage to harness any *incentives* for poor people to continue with, or invest in, the intervention. However, in the intensely competitive markets of private education, the incentives lacking in traditional aid interventions are everywhere, and paramount. School proprietors are hungry for innovation. Why? First, simply because, whatever the critics of private schools for the poor may claim, many care about children's education. On its own, this might be enough for some to invest in new innovations. But, the power of the market means that it's coupled with another major incentive: pro-

prietors know that they are in an increasingly competitive market. They need parents to know that their school is special, to maintain or increase market share. If a method of learning seems to have demonstrably better outcomes, they'll want it for their schools. If a method of payment leads to an easier life for parents, as it seems to in the example of Ghana above, again they'll want it in their schools. These incentives are completely lacking in the government system.

Conclusions

Private education is becoming increasingly widely acknowledged as providing higher quality education for the poor than the government alternative. Critics, however, claim that it isn't part of any solution for 'education for all' because there are problems with access and equity, and the quality of provision (while better than government schools in general) is far too low to be of value. I contend that neither of these problems are insurmountable. With targeted vouchers or scholarships, access for the poorest of the poor, and to girls, can be made available. And quality improvements can be brought about in the low cost private school sector, and several bodies are exploring ways of doing exactly this. Importantly, because of the power of the market in education, once ways are found that do bring about improvements, you can be sure that other entrepreneurs will quickly imitate the successful solutions.

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The Role of Masdar Initiative and Masdar Institute of Science and Technology in Developing and Deploying Renewable Technologies in Emerging Economies

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Abstract

Masdar Institute of Science and Technology has been established to play an integral role in the Emirate of Abu Dhabi, United Arab Emirates, in researching, developing, implementing and exporting new technology related to alternative energy and sustainability. The institution is the key element of a wider initiative by the Government of Abu Dhabi to find sustainable alternatives to fossil fuels by developing technology that will be scalable and provide commercially viable solutions globally.

This paper examines the opportunities and precedents for Masdar Institute of Science and Technology to play an integrated role with business, government, policy makers and society to advance the cause of sustainability, and develop models that could be easily adopted by developing countries in Africa and other parts of the world.

Introduction

The United Arab Emirates is one of the world's wealthiest countries and in recent years has enjoyed an impressive growth rate. Nominal Gross Domestic Product (based on current prices) grew 16.8 per cent in 2007 to AED729.73 billion (USD 202.7 billion). In 2006 it recorded a 28.7 per cent growth in GDP, and in 2005 it came to 25.6 per cent. [1] The historical source of the country's enormous wealth has been its hydrocarbon assets; however a careful strategy of diversification has helped balance the contribution from oil and gas with other sectors. In 2007, the non-oil part of the economy contributed 64.1 per cent of overall GDP. [2]

Nonetheless, hydrocarbons remain the single most significant sector in the country's economy. It has the fifth largest proven oil reserves [3] and the fourth largest gas reserves in the Middle East [4]. After oil was discovered four decades ago, the country has used its riches to invest heavily in creating infrastructure, and developing modern cities where none existed before. The first tar road was reportedly only constructed in the nation's capital, Abu Dhabi, in the 1960s, and photographs from as late as the 1960s and 1980s reveal that it was little more than a small town. Today, the UAE has a population of 5-million [5] with Emiratis (UAE nationals) comprising 18% and the remainder comprising expatriate workers from more than 200 nations. The

population is clustered around the three main cities – Abu Dhabi, the capital, Al Ain (the second largest city in Abu Dhabi Emirate) and Dubai.

In 2008, Abu Dhabi launched its strategic five-year plan for 2008 to 2012. The objective of this diversification and liberalization program is not to move away from a hydrocarbon-based economy. Rather, it is aimed at building a more business-friendly environment that leverages the strength of its oil and gas sector to strengthen existing industries, move into new sectors, and to transform its economy from a conventional, labor-intensive economy to one based on knowledge, technology and highly-skilled labor.

As part of its diversification, the Emirate has started investing heavily in alternative energy to protect its position as a leading energy player in the world, and to help develop the UAE into a knowledge-led economy to ensure that it rapidly reaches a position where intellectual capital can be exported rather than imported, as is the case at present. It is important to remember that while the majority of foreign workers in the UAE are unskilled, the country has relied heavily in the past few decades on attracting a skilled foreign workforce, which has played a significant role in helping the UAE play catch-up with the rest of the world.

The social and political history of the UAE provides important context to understanding the investments in the area of renewable energy and sustainability. The country only came into being as an independent nation in 1971 after existing as independently run 'trucial' states under the colonial mantle of the United Kingdom. In addition, the largely nomadic native inhabitants had little or no access to institutionalized education or technology until the sec-

ond half of the 20th century. As late as 1975, the rate of adult literacy was 54% among men and 31% among women. Today, literacy rates for both genders are nearly 90%. [6]

At first glance, the casual observer may think that the UAE has little in common with Africa, however a closer look reveals many similarities: vast natural resources; significant development requirements; a colonial legacy; tribal cultures; and historically insufficient education. Clearly Africa has a number of critical concerns – conflict remains rife, poverty is widespread, unemployment is high, and socio-economic stability is fragile. Nonetheless, African countries have the same needs as the UAE – energy security, the creation of diversified economies, and the requirement to promote education. Currently, the UAE is making great strides towards these targets. This is not an achievement it plans to guard jealously because it understands that it does not exist in isolation from the rest of the planet. Indeed, the Abu Dhabi Fund for Development has created a special endowment of up to US $50 million until 2016 to be used for loans in support of renewable energy projects in the developing world.

In the UAE, recognition that education is pivotal to its over-arching goals has been mirrored by the acknowledgement that standards need improving. This has triggered initiatives at all educational levels, as well as invitations by the UAE to foreign universities to establish campuses in the country. For example, in 2006 an international partnership agreement was signed in 2006 between the Abu Dhabi Authorities and the Sorbonne, which was established over seven hundred years ago. Investment in improving the quality of education at primary and secondary schools is designed to raise the standards of education to a level where UAE students are able to graduate from high school with the requisite skills to meet the entrance criteria of universities around the world. Currently, many students need to complete two-year foundation courses after they complete secondary school in order to meet the entrance criteria of foreign universities. [7] The Abu Dhabi Education Council has identified four main subject areas as needing specific attention: Mathematics, Science, Arabic and English.

It is a given that improving education standards is a long-term investment, and that there is no 'quick fix'. The enhancements to the primary, secondary and tertiary education system may well take a generation to bear fruit, and the contribution from foreign universities, such as the Sorbonne and New York University, will similarly not produce results overnight. Still, each one represents an important element of a strategy to become a knowledge exporter. When combined with the Government's determination to find ways to secure its global role as one of the planet's most important energy producers, both arguments provide two of the cornerstones of the creation of the wider Masdar Initiative. Education, energy and the environment are all inextricably connected to the country's future.

The current administration in Abu Dhabi, which is the nation's capital, frequently invokes the legacy of the late Sheikh Zayed bin Sultan Al Nahyan, founding president of the UAE. Sheikh Zayed is widely credited with promoting investment in educating the youth, and raising awareness of the need to preserve the environment. The influence of the late 'founding father' of the UAE is significant, and it has played an incontrovertible role in the current strategy to find sustainable and renewable sources of energy.

The formation of Masdar and its various affiliated and subsidiary companies represents the Government's most important commitment to its goals of developing sustainable, alternative energy and creating a knowledge economy. Masdar was established by Mubadala Development Company (Mubadala), which is a Public Joint Stock Company headquartered in Abu Dhabi, capital of the United Arab Emirates. Mubadala's sole shareholder is the Government of the Emirate of Abu Dhabi. Related to Masdar but operated and funded completely independently is the Masdar Institute of Science and Technology, which was established in 2007 to become the Middle East's first graduate institution dedicated to the research and development of sustainability and renewable energy. The first intake of 88 students was enrolled in five Masters programs in September. The Institute was established with the support and collaboration of the Massachusetts Institute of Technology. Most of the 21 faculty at Masdar Institute spent time at MIT ahead of the first academic year to formulate the curriculum.

The Institute is not only working at the graduate level, however. As previously mentioned, school curricula are being overhauled, and the Institute has signed a Memo-

randum of Understanding with the Abu Dhabi Education Council, and the Ministry of Education to assist in raising the level of instruction in these subjects.

Research conducted by Dr Georgeta Vidican at the Masdar Institute has shown the value of universities in innovation and sustainable development in five areas. Apart from contributing to primary research and combining existing knowledge, universities also play an important role in education and training (curriculum development); creating space for open exploration of ideas; and in involving communities. It is not only technology development that is important, but also the other contributions to bringing about positive social change. [8]

The rapid emergence of climate change as a global issue affecting everyone on the planet, combined with the lack of technology, policy and infrastructure to tackle the problem adequately has created the impetus for greater involvement by academia. Universities are able to transcend all the other traditional pillars of society – government, business, and civil society – to help develop solutions in more productive and efficient way than each of the pillars could do individually. Universities are critical in pushing technological frontiers and setting the agenda for future research by providing a space where researchers, the private sector, and government can come together to explore technology and industry pathways.

This is precisely what Masdar Institute is doing: it has a mandate to develop sustainable and renewable alternatives to fossil fuels in an environment where it will be able to 'test' emerging technology in Masdar City, which is the arm of Masdar Initiative that will house sustainability enterprises in a zero-waste, carbon-neutral city. The entire value chain of Masdar Institute will encompass theory, research, testing, application and commercialization in an environment that will be a role model for cities of the future. In addition, the decision to locate the headquarters of the new International Renewable Energy Agency in Masdar City will allow the Institute to become involved in policy formation for the entire planet.

As Vidican also notes, universities are able to contribute to industrial transformation by increasing the capacity for scientific and technological problem solving. [9] The legacy of the UAE regarding education – a situation shared by many developing nations - has produced relatively low ability in both these areas. Leveraging a strong resources base to develop academic centers of excellence can transform a society from one reliant on outsiders for technology to a nation that becomes an exporter of innovation.

A recent study has underscored the value that universities play in both innovation and stimulating economies, using MIT as the core example. The Kauffman Foundation produced a study that was published in early 2009, analyzing the economic effect of MIT on Massachusetts. [10]

According to the study, if the active companies founded by MIT graduates formed an independent nation, the combined revenue would make it the 17th-largest economy in the world. "Within the US, these companies currently generate hundreds of billions of dollars and hundreds of thousands of jobs to regional economies, particularly those in Massachusetts and California. Globally, a less conservative estimate of their annual world sales would equal $2 trillion, producing the equivalent of the 11th-largest economy in the world." [11]

The report was based on a 2003 survey of all living MIT alumni, with additional detailed analyses, including recent verification and updating to 2006 of revenue and employment figures. According to the survey, about 6,900 MIT alumni companies with worldwide sales of approximately $164 billion are located in Massachusetts alone and represent 26% of the sales of all Massachusetts companies. [12] In addition, 4,100 MIT alumni-founded firms are based in California, and generate an estimated $134 billion in worldwide sales. [13] States currently benefiting most from jobs created by MIT alumni companies are Massachusetts (estimated at just under one million jobs worldwide), California (estimated at 526,000 jobs), New York (estimated at 231,000 jobs), Texas (estimated at 184,000) and Virginia (estimated at 136,000). [14]

Another reason MIT is so important to the Massachusetts economy, is that without the university, most of these companies never would have been located in Massachusetts. [15] Most of the MIT alumni companies in Massachusetts were founded by former students who came to the state to attend MIT, liked what they saw, and eventually started their companies there. Less than 10 percent of all MIT undergraduates grew up in the state, but approximately 31% of all MIT alumni companies are located in Massachusetts. [16]

Not only do MIT alumni, drawn from all over the world, remain heavily in Massachusetts, but their entrepreneurial offshoots benefit the state and country significantly. [17] More than 38% of the software, biotech and electronics companies founded by MIT graduates are located in Massachu-

setts, while less than 10% of arriving MIT freshman are from the state. [18] More than half of the companies started by MIT's foreign-student alumni are located in the US, creating their primary employment and economic impacts here. [19]

Another good parallel is provided by the role that Stanford University played in the creation and evolution of Silicon Valley. Similar to Stanford, Masdar Institute will be the center of gravity for renewable energy and sustainability activity in Abu Dhabi, and in particular to Masdar City. It will provide a mobile, high quality workforce; a culture that rewards risk-taking; a spirit of community collaboration even in a competitive environment; the availability of financial resources; university interaction; quality of life; government involvement especially in terms of supporting research; and specialized business support infrastructure. [20] In addition, other research has shown that additional factors also play an important role: university encouragement of an entrepreneurial spirit and collaboration with industry, among other factors. [21]

As a result of the involvement of Stanford, university staff, faculty and graduates have launched over 1,200 companies in the past five decades, and more than 50 percent of Silicon Valley's products come from companies created by Stanford alumni. [22] Just as Stanford and Silicon Valley provided a role model for Masdar and Masdar Institute, so can the Abu Dhabi effort create a model for other developing nations to copy for their benefit.

As previously indicated, the role of Masdar Institute will not be restricted to graduate education. Alongside a global focus that will manifest in a collaborative relationship with the International Renewable Energy Agency (IRENA) and other leading universities from around the world, is a local approach to transform the UAE's behavior via community outreach. Much has been said about the UAE having the highest ecological footprint in the world [23], and other environmental issues – such as water conservation and waste disposal – require concerted action. Already the Institute has started some small programs to educate the local and expatriate populations about the importance of sustainability and the need to develop renewable energy sources. In the next calendar year, a number of more ambitious programs will get underway to begin educating children and adolescents in the UAE (and later across the Middle East) about sustainability concepts. In addition, the Institute has signed a Memorandum of Understanding to help the Abu Dhabi Education Council raise the standard of curriculum and instruction in the subjects of Mathematics and Science – both being key subjects in a wide-ranging improvement program initiated by the education authorities.

Vidican notes that through their interactions with local governments, universities can develop programs that involve local communities more effectively than the government or private sector can, while also maintaining their core competence in education and research. [24]

The relationship between universities and business is equally important. The Masdar Initiative aims to create a new 'Silicon Valley' around sustainability and renewable energy at Masdar City. The aim is to attract companies that are investing their own funds into developing products and services that will have the same multiplier effect on sustainability as Silicon Valley had on the IT industry. However, the private sector cannot – and will not - provide all the solutions, due to vested interests and competition. The role of universities in cutting across the interests and capabilities of government, business and civil society is further supported by Vidican's research, which reveals that whereas universities are committed to the exchange of ideas and knowledge, the private sector is far more proprietary. [25] Unlike academia, entrepreneurial enterprises are beholden to stakeholders that want a tangible return on their investments – and this generates secrecy and competition. Some areas of sustainability may well prove too expensive for the private sector to research and develop, with no guarantee of a return. In this scenario, the value of academia is immeasurable, by ensuring that all the challenges are addressed – and not only those where the profit motive is clear. In Masdar Institute's case, its role is even more essential: it has a mandate not only to develop alternative energy and sustainable technologies, but to do it in a way that is significantly scalable, and – equally importantly – cost effective. The private sector's motives are different and clearly not necessarily motivated by providing the best product at the cheapest price for a mass consumer audience.

Dr. Toufic Mehzer, another of the leading academics at Masdar Institute, has produced in-depth research on the role of the "Technology Triangle" in helping Middle East economies to develop in instances where there has been damage to social, environmental, and human resources. Mehzer describes the Technology Triangle as strategic in-

teraction and cooperation between the scientific and research community, business and industry, and institutions of governance. [26] The Technology Triangle is focused on human capital development, business development, building up the infrastructure, wealth generating capacity, competitiveness, and the sustainable development of the country. [27]

Notwithstanding the importance of academia in transcending the natural limitations of the other pillars of society, it is important to remember – as Mehzer established – that science and technology institutions depend on government and the private sector. [28] The government presses institutions for better performance in return for financial support. Pressure is also exerted by the private sector in terms of the quality of their products and services – the human capital as well as the intellectual property. If all three parties of the Technology Triangle meet each other's needs, the Technology Triangle becomes an effective mechanism for sustaining the technology capabilities of a society. [29]

Conclusion

The effective functioning of a society that is pursuing both economic growth and environmental sustainability rests on the efficient functioning of the education system. This is true in other areas as well, such as banking and finance – poor education impedes the ability of populations to use sophisticated financial services.

Masdar Institute is cognizant of the integral role it is playing towards achieving the goals that have been set by the Government of Abu Dhabi. Given that it is essentially the first graduate academic institution in the world that is devoted to the study and development of renewable energy and the promotion of sustainability, it will be sailing through uncharted waters. Clearly precedents exist, as Vidican and Mehzer show, providing some guidelines for the Institute. Furthermore, there is nothing that Masdar Institute is attempting that can't be replicated in other parts of the world facing similar challenges.

With the emphasis so firmly on developing alternative energies that are scalable and cost efficient, Masdar Institute's output from the afore-mentioned collaborations with government, the private sector, IRENA and others will be of value to other developing economies. Perhaps more importantly, its success will offer a very positive role model, allowing developing economies to benefit from the achievements of one of their own.

To paraphrase from a well-known parable about teaching a man to fish, if the UAE and other fossil fuel producers provide developing nations with non-renewable energy, they will only be able to help them until the fuel – or the money – runs out. Given current projections, this deadline is rapidly approaching. But by sharing new technology and sustainability innovations, and making them affordable and scalable, the UAE will aid developing nations in coming up with their own solutions. As the countdown clock ticks ever louder for our planet, it is in all our best interests to offer a helping hand.

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Building Knowledge by Overcoming the Dualistic Mindset in Education

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Abstract

This article reviews recent research on the process of learning in education. The research findings reveal that students are active learners whereas instruction in schools continues to treat them as passive objects that vary in their capacity to uptake knowledge. In spite of this widely-known insight that learning arises out of action, many educators, particularly in poor developing countries that still rely on old-fashioned school systems adopted from the colonial past, rely on ready-made information following a dualistic view of mind and body. Presented with rules to memorize, students are not encouraged to question or develop their own rules but to accept what adults provide. However, the static dualistic mindset is of little help in a complex and ambiguous world. It stifles real learning and problem solving, and thwarts the adoption of social and political responsibility. Real life understanding should not be discarded as irrelevant but as an essential part of an bottom-up, active learning process guided by knowledgeable mentors.

Introduction

For many centuries it has been assumed that conscious reason is predominant in optimal human functioning. In this view, the body and its passions are to be tamed so that conscious reason can learn and wisely guide life's choices. Education was about providing knowledge and accumulated wisdom to the young mind for absorption out of which good decisions and choices would emerge. Early cognitive science adopted this dualistic perspective, reducing cognition to mental events and brain processes. But this is an outdated view. The last few decades of psychological science have shown that the cognitive unconscious governs most everyday tasks [1] . For example, Libet (1985) showed how the body begins to take an action before the decision is made by the conscious mind [2]. The unconscious mind, based on varying layers of tacit knowledge, makes many decisions without our conscious awareness [3] .

But even more importantly, it is becoming more apparent how understanding is *embodied*. Instead of residing in a mind that can reason and function apart from the body, the "embodiment" view places our understanding in physical experience. For example, Lakoff and Johnson (1999) uncover the myriad body-based metaphors that humans use to express themselves (e.g. for thinking, we say "I *see* what you are saying," "where are you *going* with this idea?" "that idea leaves a *bad taste* in my mouth")[4]. Damasio's (1996; 1999) "somatic marker hypothesis" points to how chemical changes in the body, occurring as signals of past experience, unconsciously guide decision making [5]. Countless studies demonstrate how thinking is aided by physical experience and how our imaginations are bounded by physicality (see Gibbs, 2005, for a review [6]).

Also in contrast to the dualistic view, embodied cognition revises the view of evolution. The human brain "did not evolve merely to register representations of the world" but instead the brain evolved "for adaptive action and behavior;" body structures co-evolved with brain structures so "it is the entire system of muscles, joints, and proprioceptive and kinesthetic functions and appropriate parts of the brain that evolve and function together in a unitary way" [7] (Kelso, 1995, p. 268). Neural events and brain systems are structured by embodied experience [8] .

If conscious reasoning is not dominant and human understanding is largely embodied, there are serious ramifications for the way schooling takes place, the way teachers teach and students learn. These are the topics of this chapter: learning and knowledge development, the embodied nature of knowledge, and the ramifications of these insights for instruction.

1 Conceptions of Human Learning

1.1 Learning as reception

Dualism still pervades human perceptions and practices, including within education. The dualistic view assumes that the mind is separable from the body and can be taught ignoring the body. In this view the mind is most important for guiding behavior whereas the body or passions are the

source of distraction and must be controlled. These notions influence how people view learning.

The more prevalent but mistaken notion of learning has been called the "receptive-accrual" view [9] . According to this view, students passively receive knowledge from the teacher. The teacher "pitches" the information to the student and the student "catches" it. Students store the knowledge as presented. If the student does not learn, it is the student's fault for not "catching" the information. The student fails due to being inattentive or stupid.

The common instructional approach for the receptive-accrual view is one where the teacher presents a "top-down" framework or set of principles developed by adults from their "bottom-up" or organic experience. The adult-learned lessons are presented as material to be memorized by the students. For example, in many U.S. classrooms, teachers present fractions in numbers and formulas on the blackboard and expect the students to complete worksheets on fractions [10] . This kind of education offers inert knowledge to students—information that a student may be able to memorize and regurgitate for a test, but is quickly forgettable. Worst of all, the student is unable to apply such inert knowledge to real life. These teachers fail to realize how children's experiences can lead to the principles themselves and how principles cannot be truly learned without such experience. Japanese math teachers appear to be aware of this. They typically help students develop knowledge from "bottom-up" experience [11]. For example, fractions are learned first through working with real-life materials before working with the numbers themselves.

The type of mis-education by adults described above frequently occurs in moral education. Some adults believe that presenting a list of virtues is nearly as clear to the students as it is to them. Adults may find a trait list helpful because they have had a lifetime of experience building knowledge about the trait behaviors and use the list as a reminder. When you mention 'honesty' to an adult, chances are that he or she recalls many personal experiences of being lied to, of lying, of the consequences of lying, of the degrees of honesty one displays based on the level of intimacy with another, of the differences between honesty and being private or polite, and so on. The label, 'honesty,' is convenient for the adult in linking together all these experiences in memory. Adults are not novices when it comes to honesty, whereas most children are. A child has had relatively few experiences with honesty, and fewer yet that are recalled. Further, these experiences may not have been reflected upon, and hence may remain closed to mental scrutiny. Advising a child to "be honest" is talking at students and likely has little effect on their skills (knowledge and application) or character development (except perhaps to think they know what honesty is because they heard about it).

Labeling a complex set of behaviors with a single word (codifying multiple experiences) does not help the novice. For example, if you tell a child to be responsible, it is like telling a person who does not know how to cook to 'make a white sauce!' he or she will be at a loss on how to proceed. Likewise, if you tell a child 'be responsible!' the child may be at a loss on how to act regardless of how many school assemblies or wall posters espouse its importance. As a result of misunderstanding learning and performance, there can be a big gap between what teachers present and what students learn. In many cases, children never apply the knowledge that teachers want them to learn.

In my research we have tested the assumption that children understand the "magic" and message of a story if you let them experience the story [12]. We told children's stories to children to see whether they could understand the intended theme [13]. Eight year olds were very poor at understanding the intended themes of stories, selecting correctly about 10% of the time, whereas 11-year-olds were better, understanding the theme about 45% of the time. Scores improve with age until perfect performance in late adolescence. These findings cannot be explained by the receptive-accrual approach but are explained by the next view of learning.

1.2 Learning as transformation

The contrasting view of learning held by those who study human learning and development is the "cognitive-mediational" perspective [14]. According to this view, individuals bring to the learning experience a set of unique conceptual structures or schemas built from previous experience. These structures influence what and how they perceive, what they understand and what they remember. Learning is defined as an *active transformation* of conceptual structures [15] rather than a passive accrual of information. The learner actively manipulates key aspects of the domain, interacting with them, testing the way they work and interact, and gauging how they help meet one's goals. Knowledge arises out of action. To know an object, one must act on it and transform it through mental and physical operations. Development proceeds by the assimilation of the environment to cognitive structures, and, reciprocally, the accommodation of these structures to the environment. Movement to higher levels of development depends on

"reflective abstraction," which means coming to know the properties of one's own actions, or coming to know the ways in which they are coordinated. Cognitive structures naturally change in the course of being used, and both the organism and the environment are involved in this process of change.

Thus we can explain developmental differences in story understanding, like those mentioned above, by emphasizing how children bring their own understanding to the learning situation. Every learner does this. If the learner does not have the appropriate background knowledge for the situation, he will not learn the material in the way intended by the teacher.

The "learning-as-transformation" perspective advocates a different type of instruction. Instead of passing inert knowledge to students through lecture and other top-down methods, students are immersed in bottom-up, active learning. For example, even during cognitive activities such as reading, good learners are active. They actively process the reading material through selective attention. They relate new information to their prior knowledge thereby forming new knowledge. They monitor understanding in order to know when to ask for help or when understanding is complete [16]. These active learning skills can be taught and are necessary for successful learning [17].

1.3 Learning as Embodied Effectivity: The Apprenticeship View

The cognitive-mediational view of transformational learning described above has been augmented by the apprenticeship view [18]. Based on naturalistic learning processes found around the world, apprenticeship learning includes not only immersion in the learning experience but also explicit guidance from a mentor. The mentor guides the learner's attention to key information and its interpretation. The mentor provides "scaffolding," just enough support for the learner to be successful, which is gradually lessened as the learner's skills develop. The learner develops a sense of the affordances (action possibilities) in the domain while at the same time a sense of effectivity (capacity for effective action).

Extensive experience in a domain is required for understanding and knowledge building generally. In older normal children, it is evident that reflective thinking is rooted in "lived emotional experience" [19]. For example, children who have more social experience have developed greater emotional self-awareness and an increased ability to use emotions effectively to think out problems. They demonstrate superior social skills, moral reasoning, and intelligence. Children with extensive free play experience are able to create more ideas and organize those ideas in a broad, analytical context—Greenspan and Shanker's definition of intelligence [20]. Children's play is found to be a powerful educator of both emotions and cognition [21]. Immersion in active learning with material can mimic the free play that is foundational for learning.

Active learning builds the icebergs of tacit knowledge that underlie behavior. Tacit knowledge is formed through the work of at least three types of unconscious processing: basic, unconscious and sophisticated [22]. These represent primitive, default processing systems that remain robust even when explicit systems are damaged, showing low variability among individuals, independence of age and IQ, and a commonality of process across species. The "basic" information processing system includes instinctive behaviors that regulate life (e.g., feeling of hunger precipitated by a drop in blood sugar that results in the conscious desire to seek food). The "primitive" information processing system keeps track of basic information devoid of meaning, such as subsymbolic processing of environmental stimuli, mechanistic registration of the frequencies and covariation of event, inferring implicit rules of systems that are encountered (e.g., grammar). It includes "somatic markers" as memory and warning devices [23]. The "sophisticated unconscious" guides perceptual processing. It attends to meaning and affect, recognizes affordances, and builds embodied structures of knowledge.

These three unconscious systems are the tip of the iceberg in terms of the type of knowledge acquisition or conceptual transformation a person performs without effort. Some tacit knowledge is conceptual but difficult to put into words; other tacit knowledge resides in neuroendocrine and other body systems. But all knowledge is embodied. Usable human knowledge is by and large dependent on this vast network of tacit or implicit knowledge, learned inside and outside of school [24]. Tacit knowledge forms the rich base of practical intelligence within a particular domain which is largely a set of schemas that change with experience [25].

2 How Does Knowledge Develop?

There is a common understanding among cognitive psychologists about how knowledge develops and it generally involves the transformation of schemas or generalized

knowledge structures [26]. The traditional view of schemas is explained first and then a more embodied view is addressed.

2.1 Schemas

The notion of schemas is one that has driven research and teaching for several decades. Working from Kant's and Piaget's notions of schemas, classic schema theorists [27] introduced schemas as general knowledge structures residing in long term memory. Schemas (i.e., expectations, hypotheses, concepts), built from brain patterns formed from experience, are shaped as people notice similarities and recurrences in experiences. Schemas are evoked (or "activated") by current stimulus configurations that resemble previous stimuli. A schema consists of a representation of some prior stimulus phenomenon; this organized prior knowledge is used to understand new information (sometimes referred to as "top-down" processing). The functions of schemas are essential to human understanding. Schemas guide attention to new information and provide guidance for obtaining further information, give structure or meaning to experience by logically inter-relating the parts, enable the perceiver to "chunk" an appropriate unit, and to fill in information where information is scarce or ambiguous, provide guidance for evaluating and for problem-solving. In short, schemas facilitate information processing. This is evident across domains, including moral reasoning [28].

A more recent discussion of cognitive schemas distinguishes among the (1) form, (2) creation, (3) types of knowledge represented and the application of schemas [29].

(1) Schemas have a particular form or architecture. They are basic storage devices represented by a tightly organized network structure. The structure is determined by the pattern of interconnections among the element which are connected positively or negatively, strongly or weakly. The degree of connectivity among constituents and sub constituents (+ or -) determines strength and accessibility. Schemas are noted for their flexibility. They can vary in size and be embedded in or overlap with other schemas. No instantiation of a schema is identical to another.

(2) Schemas are not memorized but constructed from experience. A schema will develop in response to repeated opportunities to solve a particular kind of problem. The schema contains abstractions from the commonalities in experience, yet they can be concrete or abstract. Their construction involves attention and selective processing. Although individuals experience life uniquely, the similarity of their experiences brings about the development of similar schemas.

(3) Schemas include both procedural knowledge (rules) and declarative knowledge (concepts and facts). Schemas can be applied subconsciously and automatically or consciously and controlled. Schema application involves analogical reasoning and both linear and parallel processing. Essentially, a schema has been considered a goal-oriented cognitive mechanism.

2.2 Instruction for schema development

How do educators begin to foster in students the vast network of schemas that make up a domain's practical intelligence? According to Marshall (2000), there are several levels of knowledge in a fully-developed conceptual network or schema, from less to more complex: (1) identification knowledge, (2) elaboration knowledge, (3) planning knowledge, and (4) execution knowledge [30]. The least complex type of knowledge is (1) identification knowledge which comes about from many different experiences in the domain. Identification knowledge establishes the boundaries of the domain. The student becomes familiar with the essential nature of domain situations and learns to recognize essential elements in the dynamic context (simultaneous processing of multiple elements in a configuration).

Complexity is added when the teacher begins to draw attention to the details of problems and patterns, fostering (2) elaboration knowledge in the students. Elaboration knowledge is declarative knowledge that enables creation of a situation/mental model. It includes individual experiences and general abstractions, including sensory information. It focuses on the details of the elements in particular situations (verbal and visual). Initially, a student uses a prototypical example with which to make comparisons. Students create a mental model of the specific problem from the specific situation or from a generalized schema.

The next layer of understanding involves solving problems in the domain. This allows the students to build (3) planning knowledge which shows them how to access identification and elaboration knowledge. Planning knowledge refers to the way a schema can be used to make plans, create expectations, and set up goals and subgoals. The schema is updated with each usage. Given more than one situation in a problem the student must acquire knowledge necessary for determining which situation to examine first and how the situations are related to one another. Student learns to formulate a plan of action. Planning knowledge is difficult to acquire, greatly dependent on having the right

mental model and being comfortable working with it. Planning knowledge is rarely displayed in overt measurable settings and is often detectable only by inference.

Finally, students begin to integrate their knowledge across contexts and build (4) execution knowledge in the domain. Execution knowledge puts everything together. Planning knowledge is used to determine the steps to take in solving a problem. Execution knowledge allows the student to carry out the plan. It consists of algorithms or techniques to complete each step in a plan. Students learn what knowledge to apply when and why. As each step is completed, the execution knowledge is called on to address subsequent steps. Below and in Table 1, we describe a project that incorporated these steps into a novice-to-expert approach to moral character education.

To this point we have been discussing schemas from an information processing perspective. This is "old cognitive science" [31]. The newer cognitive science pays attention to the body-mind-environment interactions. Ideally, students have multi-sensory experience in a domain so that several routes are established for building and accessing knowledge schemas (i.e., material is presented in *different modes:* visual, auditory, tactile, kinesthetic, olfactory, musical and in ways that foster *different types of thinking*: analytical, practical, creative, predictive, retrospective, motivational). This is best described in terms of "embodied schemas."

2.3 Embodied schemas

We can change slightly the notion of cognitive schemas as facilitators of information processing so it more clearly reflects embodied knowledge. Instead of a disembodied mind that learns and applies knowledge, we know now that body, mind and environment are linked. Proper units of knowledge are primarily *concrete*, embodied, incorporated. Knowledge is about situatedness. The uniqueness of knowledge, its historicity and context, is not a "noise' concealing an abstract configuration in its true essence" (Varela, 1999, p. 7) [32]. Instead, the "noise" is the context-specific knowledge required for successful interaction with that situation. Embodied cognition results from 'mesh,' the particular way that situational affordances, knowledge, and goals combine [33].

Because human behavior is goal-directed, categories of knowledge emerge from goal directed behavior. For example, the infant learns "that a certain category of force dynamics is appropriate for a certain class of tasks" [34]. The organism actively constructs a sensorimotor representation based on environmental features that are directly relevant to the goal-directed action being currently performed.

Thus perception-action-knowledge is contextualized. We are embedded in space and time, which constrains interactions, the "processing' of environmental information. The same space is viewed differently by the same organism depending on the type of task to be performed at the time. The particular goal-directed activity determines which environmental features are relevant to the performance of the activity. Sensorimotor experiences that occur while acting in a particular environmental context specify the type of categories/concepts the organism forms. Our goals and capacities interact with the specific environmental configuration in our learning of "what works" to be effective in that situation. Humans, like all organisms, are continuously self-organizing, self-developing and so we quickly learn these perception-action links. "The system can generate its own change, through its own activity, and within its own continuing dynamics, be it the spring-like attractors of the limbs or the neural dynamics of the brain" [35].

If learners are self-organizing, if knowledge is contextualized, then how does instruction incorporate these factors? Novice-to-expert instruction provides the apprenticeship model that most closely mimics natural, embodied learning, and schema development.

3 Novices and Expertise Development

> *"Billy has an IQ of 121 on a standardized individual intelligence test; Jimmy has an IQ of 94 on the same test. What do each of these scores, and the difference between them, mean? The … best available answer to this question is quite different from the one that is conventionally offered---that the scores and the difference between them reflect not some largely inborn, relatively fixed ability construct, but rather a construct of developing expertise. I refer to the expertise that all of these assessments measure as developing rather than as developed because expertise is typically not at an end state but is in a process of continual development." [36]*

The abilities that are fostered by schooling are now considered to be a set of capacities that develop continuously from experience [37]. According to this paradigm, individuals build their knowledge over time during the course of immersion in and interaction with the elements of a particular domain. In this view, standardized tests are not

measuring innate capacity but how much expertise the respondent has developed in a particular subject area or domain (and how much expertise the respondent has at taking such tests).

So if we see school learning, like all learning, as developing expertise, we need to examine what expertise is (for a review of literatures, see Ericsson, Charness, Feltovich, & Hoffman, 2006 [38]). Expertise is the ability to solve problems effectively within a domain. According to Sternberg (1998), expert skills include the ability to develop sophisticated representations of domain problems based on structural similarities [39]. Experts work forward from given information to implement strategies for finding unknowns in problem solving. They choose a strategy based on elaborate schemas for problem solving and use automated sequences of steps in problem solving. They are highly efficient and effective problem solvers who monitor their success in reaching a solution.

Experts focus on the key patterns and information needed to solve the problem, whereas novices are distracted by superficialities (e.g., Vicente & Wang, 1998 [40]). Experts have large, rich, organized networks of concepts (schemas) containing a great deal of declarative knowledge about the domain, whereas novices have superficial knowledge [41]. Experts have well-organized, higher interconnected units of knowledge in the domain that have developed from extensive experience in the domain [42]).

3.1 Expertise development

Expertise requires extensive study and deliberate practice [43]. Unlike the lay person, experts have the benefit of learning tacit knowledge and explicit knowledge in tandem [44]. They have networks of schemas linking their tacit and explicit knowledge banks. They develop a whole set of skills including reflective, deliberative skills, routines and superior processing capabilities.

As mentioned previously, like many experts, adults generally forget what it is like to be a novice [45]. Whitehead (1929) pointed out that whereas individuals learn from experience and then abstract and codify their experiences, adults focus on the codifications they have made from their experience when they educate the next generation, burdening the children with inert knowledge [46]. Yet society typically understands this to be good education. Knowledge presented in this manner might be memorized but not learned in a way that is useful unless the top-down principles are accompanied by bottom-up experience.

In primary and secondary schooling, there are many subjects to be covered and little time to spend on each one. Nevertheless, teachers can approach the subject matter as a domain of knowledge that novices can, over time, learn to master. Nurturing mastery of a domain is a lifelong endeavor. Teachers have a chance to help students develop the attitudes and motivation to monitor their own progress towards expertise.

3.2 Novice to expert instruction

Real life understanding requires a pedagogy that integrates immersion experiences with mentor-guided interpretation. There are four features of education that are fundamental for developing expertise. First, an environment that rewards appropriate behaviors is critical for learning effective intuitions about the domain. Second, mentors should provide links to theory at the appropriate moments for maximal learning. Third, students require extensive practice. Fourth, students require the mentor to guide learning, coaching the student on what to attend to, what details are important and what skills to apply.

The environment. We have noted what every individual effortlessly does with stimuli through interaction with the environment—finds contingencies and regularities, creates body-mind-context patterns of response, and so on. This is the normal course of learning for the lay person. The environment plays a large role in what is learned. According to Hogarth (2001), the environment provides learning structures (the characteristics of the task in which we learn from experience), which shape the intuitions that drive us [47]. Through direct experience, people learn content, rules, and "cultural capital." People learn by noticing associations or contingencies. Rewards and punishments reinforce memories for some associations over others. Conceptualizations are associated in the mind through spreading activation of schemas.

According to Hogarth (2001), some environments are more favorable in providing quick and accurate feedback. Because we aren't aware of the learning structures in the environments we inhabit, we can learn the wrong lessons and end up with erroneous intuitions [48]. This can happen when a child has parents who are depressed or addicted. The affordances of one environment may not generalize to others or to most environments, leaving an individual with a poor set of responses to generalize. A child that has learned to respond casually to inconsistent and undemanding parenting may not learn skills of listening, following through, or empathy. In contrast, experts have learned their skills in more favorable (well-structured) environ-

ments—environments that provide them with accurate feedback on whether they are learning what works. Experts immerse themselves in the appropriate domain environment.

Theory. It is not only the superior, controlled environments that contribute to the development of expertise. Experts-in-training learn theory too. Instructions for expertise involve explanation of key principles in the domain, why certain things are better than others. Along with the implicit learning that comes from immersion in a situation, experts-in-training are given theoretical tools to 'see' the domain [49]. Experts become experts in part because they use/ learn explicit theory developed by previous generations of their profession.

Practice. But there is more to building expertise than a well-structured environment and learning theory. Experts put in a lot of time and focused effort/practice in the domain. Some argue that this is the key to expertise and that it takes about 10,000 hours or 10 years of focused practice [50].

Guidance. In order to build expertise, novices need a "guide on the side," someone who will point the way at critical times in their learning, and someone who will model effective behavior in the domain.

In sum, teaching for expertise differs from the usual approach to instruction in schools. Students are immersed in a well-structured environment. They explicitly learn theory. And they spend a great deal of time on focused, deliberative practice. Through these practices in combination they learn representations, many of them action schemas, cognitive conceptual networks or mental models, along with physiological responses of what works to solve domain problems.

4 An Example

The Minnesota Community Voices and Character Education project (CVCE; Narvaez, Bock & Endicott, 2003; Narvaez, Bock, Endicott & Lies, 2004)[1] [51] adapted the four schema development levels (identification, elaboration, planning, execution) to four levels of novice-to-expert instruction for moral character education in schools. CVCE identified sets of skills that are necessary for taking moral action. These include skills in four components that are necessary for moral behavior [52]. These components are *ethical sensitivity* (e.g., perspective taking, working with diverse individuals and groups, controlling social bias), *ethical judgment* (reasoning about ethical problems, considering consequences, developing resilient thinking), *ethical focus or motivation* (e.g., acting responsibly, showing respect, developing integrity, and *ethical implementation or action* (e.g., resolving conflicts peacefully, persevering, taking leadership). In Table 1 shows the levels of novice-to-expert instruction that could be used for the subskill, Being a Good Steward, from the skill, Acting Responsibly, which falls into Ethical Focus.

5 Policy Implications

In the USA, ideas about learning as knowledge transformation have been kicking around at least since John Dewey (1916). The government, through the National Science Foundation, has been funding research that emphasizes teaching for understanding and knowledge transfer [53]. For example, for forty years Project Zero (http://pzweb.harvard.edu/) has spearheaded projects that aim to help teachers teach for understanding in math, science, arts and across disciplines. The goal is to teach in such a way that students do not only understand domain information but are able to expand upon it, and then apply it in new ways.

Conclusion

Despite advances in our understanding of how people learn, much of education continues to focus on inert knowledge that a child may be able to memorize and regurgitate for a test, but is useless in real life. Real life understanding requires a pedagogy that integrates immersion experiences with mentor-guided interpretation. Instruction that embraces the embodied nature of human understanding ensures that students are holistically engaged in active transformation of the domain. Educators provide theory, extensive practice and guidance that novices need to reach towards expertise in their particular local environment. Novice-to-expert instruction engages both the implicit, intuitive mind as well as the conscious deliberate mind, leading to the most adaptive understanding. In this context, governments in developing countries who are eager to improve the quality of education and ensure its practical relevance for local development may consider a dual-track approach in which schools partner with local entrepreneurs and innovators that could adopt the role of mentors and thus enrich the school-based education and work-based training segments.

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Table 1. Component: Ethical Focus

Skill: Acting Responsibly

Subskill: Being a Good Steward

Level 1: Immersion in Examples and Opportunities

Attend to the big picture, Learn to recognize basic patterns

Examples of stewardship. Present students with examples of people (readings, video) who describe their stewardship and what they think about stewardship. Students notice what motivates stewardship and how different people define it. They can develop a set of defining characteristics of stewardship, as well its variations.

#History of stewardship. How have organizations practiced stewardship or not? Have your students break up into groups and choose and present on a particular group that has shown or not shown stewardship (e.g., the World Wildlife Federation, Exxon Mobil).

***Examine local stewardship.** How do local organizations and traditions practice stewardship? Students interview representatives of local groups about their views and practices of stewardship and report on their findings.

+Limits of resources. Discuss the limits of all resources (ecological, social capital, personal energy, time—hours in the day) and how people are always making choices (usually not consciously). Read recent papers or websites on the limitations of resource use (e.g., 350.org). Examine Jared Diamond's thesis in the book, *Collapse*, and how runaway resource use can bring down societies.

LEVEL 2: ATTENTION TO FACTS AND SKILLS

Focus on detail and prototypical examples, Build knowledge

#Create videos demonstrating stewardship. Based on their findings about how organizations are good stewards, students work in groups to create videos demonstrating stewardship.

***Brainstorming exercise on stewardship.** After defining what stewardship is, have the students brainstorm about different ways that the classroom and school or they and their families have shown good stewardship. How have people whom they know shown good stewardship? Make sure to look across domains such as economic, ecological, social-relational, civic, intellectual, gifts and talents.

+Assessing resource availability. Find examples of ways that people budget their resource use. Using a broad view of stewardship across domains (e.g., economic, ecological, social-relational, civic, intellectual, gifts and talents), what are some effective ways that the students budget their own resources? Discuss how stewardship might be improved based on examples from others.

LEVEL 3: PRACTICE PROCEDURES

Set goals, Plan steps of problem solving, Practice skills

#Self assessment on resource use. Students keep a record of how much of the following they use in one week: water, heat, electricity, foods, transportation, etc. Students come together and graph their usage of each resource. Students set a goal to improve stewardship and after practicing for a week or more, regraph resource usage.

***Write letters of thanks to those who show good stewardship locally.** Have the students write letters to the local groups and clubs that have shown admirable stewardship in their group's activities. Include in the letter the ways in which the groups' stewardship has inspired the class and helped the community.

+Planning stewardship. After investigating their own stewardship and the options for conserving and managing resources, students make a specific plan for improvement in one small area of stewardship. Students make a plan, carry it out and then report on the results.

LEVEL 4: INTEGRATE KNOWLEDGE AND PROCEDURES

Execute plans, Solve problems, Transfer knowledge across situations

#Resource budgeting. Using information from their self assessment on resource usage, have students budget themselves on resources usage in multiple areas or in an area that is more difficult (e.g., energy usage). The class or group can decide together on limits. **Assess** by having students keep track for a week and report to their group and class.

***Group stewardship practice.** Students participate in a local group that practices concrete forms of stewardship (e.g., recycling, roadside clean-up, etc). Reflect and share reports on the experience.

+Local expert guidance in planning. Have the students invite and host a local expert(s) on stewardship in a particular domain, e.g., energy conservation expert, recycling commissioner, etc. Ask the local expert to help the class develop a plan for stewardship (for the class, the school). Plan to involve other classes, teachers, students in the plan. Invite the expert back in several months to hear reports about how the plan implementation has progressed.

#*+ These symbols link activities that can be linked together for a sequence of novice-to-expert instruction.

Vocational & Professional Education and Training in Switzerland: A successful public-private partnership

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Abstract

By systematically linking training components to the labour market, Switzerland has managed to achieve with 7.0 % one of the lowest youth unemployment rates compared to the OECD average of 12.4%. The following article describes the main features of the Swiss vocational and professional education and training (VET/PET) system as well as of the Swiss system of universities of applied sciences (UAS). The entire education system has various pathways enabling people to shift from one part of the system to another. About 90% of all vocational education and training (VET) programmes in Switzerland are based on the dual-track approach in which, vocational schools partner with host companies and – in some cases – industry training centres to share the burden of education and training across school-based and work-based training segments. Responsibility for vocational and professional education and training is shared by the Confederation, the Cantons and the professional organisations. This public-private partnership ensures a close match of the content of vocational and professional education and training (VET/PET) programmes with the needs of the employers and the labour market.

Introduction

The Swiss VET/PET system traces its roots back to the guild system where education and training was provided by businesses specialised in craftsmanship. The first vocational schools to combine theory and practice were the watchmaking school in Geneva, founded in 1924, and the trade school in Bern, founded in 1928. These schools emerged from commercial activities and private initiative. Larger industrial companies would also play a pioneering role. In 1870, the Swiss technology corporation Sulzer created a school that would later provide inspiration for combined school/work-based VET programmes in Switzerland. At the time, the Sulzer school trained metalworkers and foundrymen on two fronts: theoretical principles would be taught in a classroom setting and then these principles would be applied during paid apprenticeships at the company. Other companies followed suit and in 1933, the first Federal Vocational Education and Training Act came into force. The combined school/work-based model was adopted for upper-secondary level VET programmes. With this approach, private host companies and public vocational schools began working closely together. In 2004, a new piece of legislation was enacted, the Federal Vocational and Professional Education and Training Act (VPETA). The act covers all fields, including health care, social care and art (which were previously excluded from the scope of VET and PET programmes). VPETA is very flexible and leaves room for various types of education and training models.. The individual branches may therefore make targeted adjustments to their training plans whenever the need arises.

1 Overview of the Swiss VET/PET System

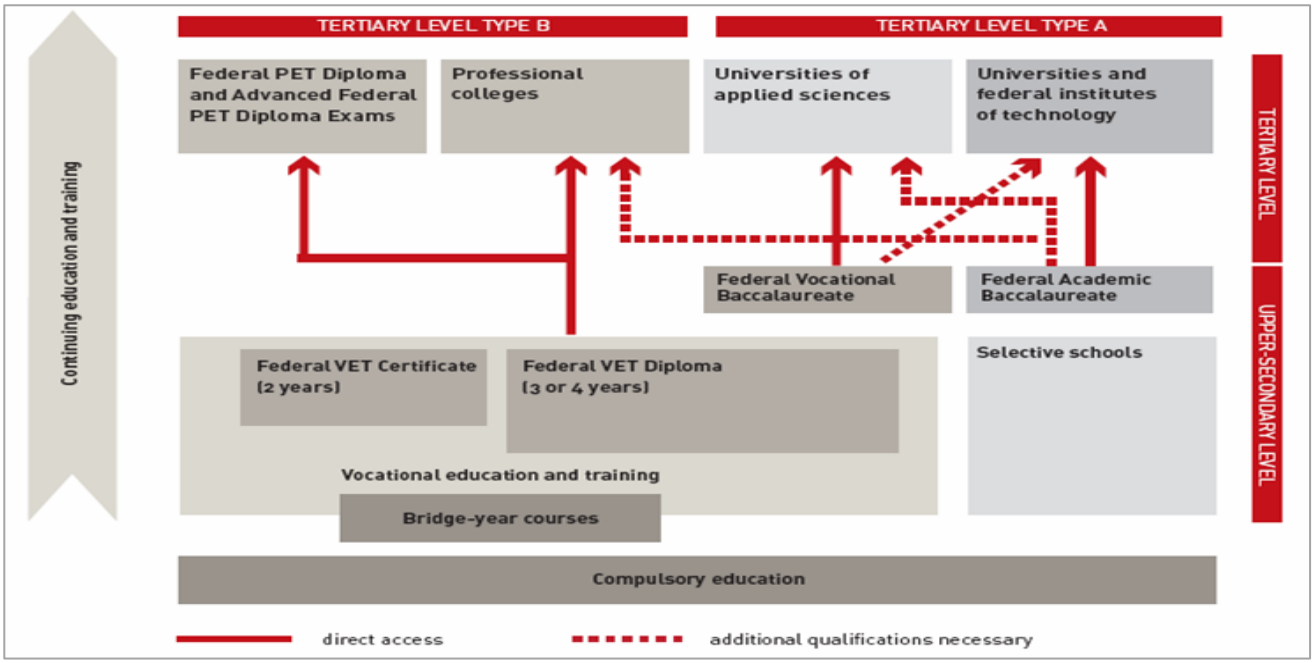
Responsibility for the Swiss education system is shared by education institutions on the one hand and the three policy-making levels (i.e. Confederation, Cantons and Communes) on the other. The Cantons have authority over all matters that are not entrusted to the Confederation. At the national level, there is no Ministry of Education. It is the Cantons that bear most of the responsibility for education. At the federal level, education matters are handled by three different federal departments: the Federal Department of Home Affairs (FDHA), the Federal Department of Economic Affairs (FDEA) and the Federal Department of Defence, Civil Protection and Sport (DDPS). The Federal Department of Economic Affairs (FDEA) works in the area of education through the Federal Office for Professional Education and Technology (OPET). OPET is the federal competence centre for vocational education and training (VET, upper secondary level), professional education and training (PET, tertiary level type B), universities of applied sciences (UAS), occupational, educational and career guidance counselling, training of VET professionals and innovation technology grants.

Switzerland's VET/PET system covers both, the upper secondary level and tertiary level type B (see Figure 1). Its legal basis is the Federal Vocational and Professional Education and Training Act (VPETA). The act was revised in 2002 and came into force in early 2004. Switzerland promotes a principle of potential upward mobility from all parts of the VET/PET system (see paragraph 1.3).

1.1 Vocational Education and Training (VET)

Vocational education and training (VET) belongs to upper secondary level and immediately follows compulsory educa-

Figure 1: The Swiss education system



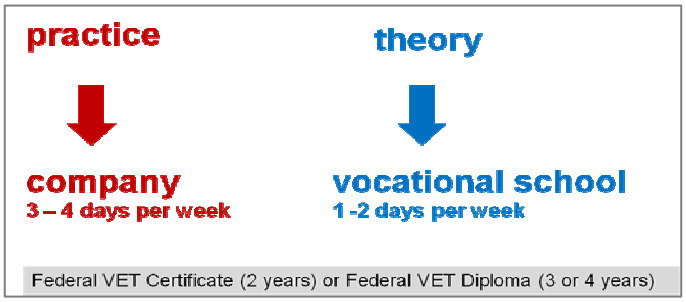
Source: OPET (2009): Facts and Figures. Vocational and professional education and training in Switzerland. Bern: OPET, p.5

tion (i.e. lower secondary level). To enrol in a VET programme, students must successfully complete lower secondary level. Special bridge-year courses are offered to young people coming out of compulsory education who have not yet gained the skills and aptitudes needed to enrol in post-compulsory education (i.e. starting upper-secondary level).

The VET programmes at upper-secondary level last two, three or four years. The two-year programme leads to the Federal VET Certificate and is intended for students whose academic achievement during compulsory education is low and does not permit them to enrol directly into a three- or four-year VET programme. Students who complete a two-year VET programme receive a Federal VET Certificate, which gives them the option of completing the three-year or the four year VET programme in less time. Students who complete a three-year or four-year VET programme receive a Federal VET Diploma, which allows them (with work experience) to continue their education at the tertiary B level and progress to professional college degrees programmes or to prepare and take national professional examinations to earn the Federal PET Diploma or the Advanced Federal PET Diploma.

VET students who obtain their Federal VET Diploma and who complete additional general education courses may also take an examination to obtain the Federal Vocational Baccalaureate. It entitles the holder to study in any of Switzerland's universities of applied sciences (UAS). If the holders of the Federal Vocational Baccalaureate successfully pass an additional University Aptitude Test, they are entitled to enrol (at tertiary level A) in any of Switzerland's cantonal Universities or in either of the two federal institutes of technology (ETH Zurich and EPF in Lausanne).

Figure 2: Dual-track VET approach



OPET illustration

Approximately two-thirds of all young people entering upper-secondary level education opt for a vocational education and training programme. About one-third enrol in a general education programme. In 2007, 126,000 young people entered upper secondary education. There are 75,000 new VET students each year.

A single or dual-track approach is used to provide students with vocational education and training (see Figure 2). With the single-track approach, all general education courses, vocational courses and vocational training courses are provided exclusively by the vocational school as a part of a full-time VET curriculum. This is also referred to as an entirely school-based VET programme. With the dual-track ap-

proach, vocational schools partner with host companies and – in some cases – industry training centres to share the burden of education and training across school-based and work-based training segments. This is also referred to as a school/work-based VET programme. About 90% of all VET programmes in Switzerland are based on the dual-track approach.

With the dual-track approach, practical training courses are carried out by host companies. These host companies organise paid apprenticeships for VET students. The apprentices spend 3 to 4 days at the host company where they do productive work while undergoing practical training. The vocational schools provide students with general education courses and vocational instruction courses. VET students spend 1 to 2 days per week at the vocational school.

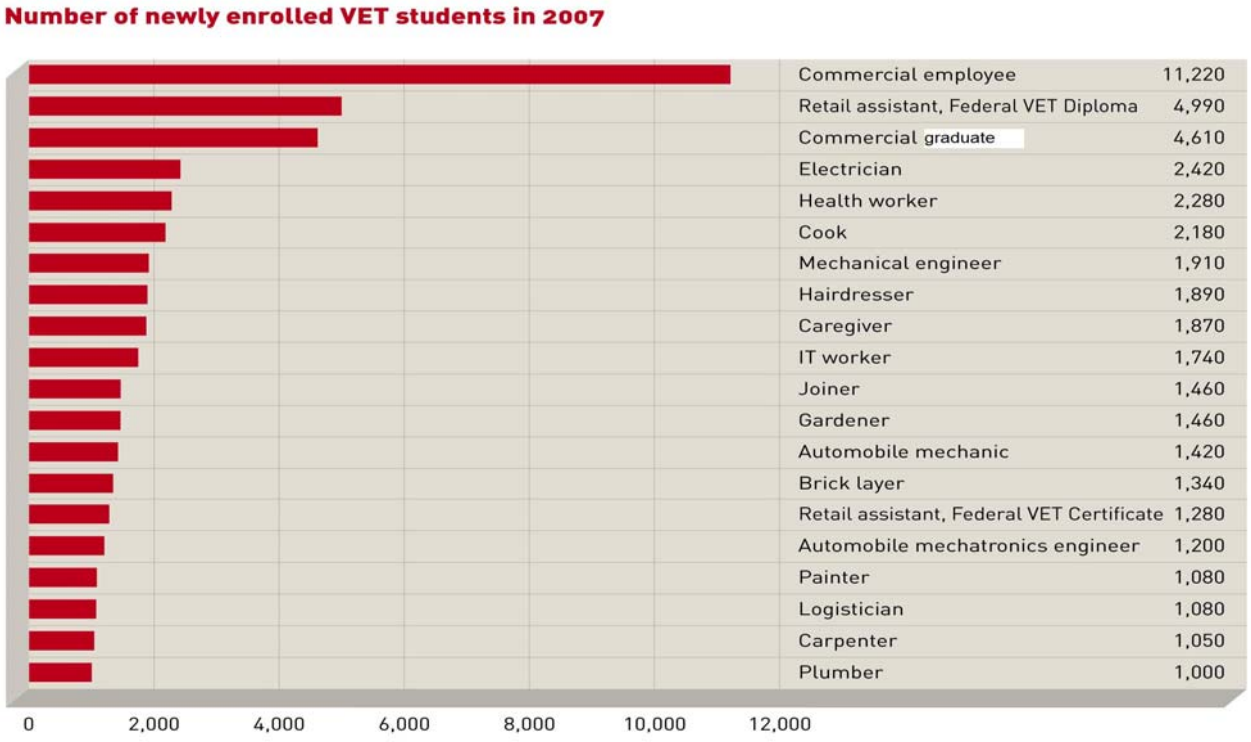
In Switzerland, there are VET programmes for over 200 different occupations. These VET programmes prepare students for initial entry into the labour market. The legal basis and the definition of content for each vocational education and training programme can be found in the education ordinances issued by the Federal Office for Professional Education and Technology (OPET). They are prepared through the joint efforts of the Confederation, the Cantons and the corresponding professional organisations (trade associations, social partners and other organisations and VET/PET providers). In addition to the education ordinances, there are training plans to structure vocational education and training courses. Professional organizations are responsible for establishing and updating the content of VET and PET programmes. The 20 most popular occupations in 2007 account for about 61% of all VET programmes (see Figure 3).

Switzerland's VET programmes are designed to match labour market needs in terms of qualifications and vacancies. The direct link between VET programmes and the labour market is the reason why Switzerland has one of the lowest youth unemployment rates: 7.0 % compared to the OECD average of 12.4.% (see Figure 4).

1.2 Professional Education and Training (PET)

Professional education and training (PET) falls into the tertiary-level type B category. It focuses on providing people with professional qualifications that enable them to handle challenging specialised or managerial tasks. Access to PET qualifications is basically open to holders of a Federal VET Diploma who have also gained the necessary professional experience. Holders of equivalent upper-secondary level qualifications who have some years of professional experience may also gain access. Graduates

Figure 3: The 20 most popular occupations



Source: OPET (2009): Facts and Figures. Vocational and professional education and training in Switzerland. Bern: OPET, p.14

from specialised schools may also be admitted to PET programmes.

PET programmes can be split into two main categories: PET programmes leading up to the national professional examinations (Federal PET Diploma Examination and Advanced Federal PET Diploma Examination) and PET programmes offered by professional colleges. In both cases, the PET qualifications are recognised at the federal level. The Federal PET Diploma examinations are handled by professional organisations. The same qualification procedures apply throughout Switzerland, regardless of which institution is responsible for providing the preparatory courses. Professional organisations are also responsible for organising national professional examinations for the Federal PET Diploma and Advanced Federal PET Diploma (both are tertiary-level type B qualifications). OPET supervises these examinations and issues the corresponding qualification. There are currently about 400 different national professional examinations and around 16,000 Federal PET Diplomas are issued each year. Professional colleges provide specialised degree programmes. In addition to attending theoretical courses, students either work in their field or take part in a traineeship. The degree programmes provided by the professional colleges are regulated and recognised by OPET. They are based on the curriculum established by the corresponding professional organisation and therefore are strongly based on the needs of the market. Around 4,000 professional college degrees are awarded each year.

1.3 VET/PET partners

Responsibility for vocational and professional education and training is shared by the Confederation, the Cantons and the professional organisations (see Figure 5). This cooperation is a fundamental principle of the VET/PET system and is set forth in Art. 1 of the Vocational and Professional Education and Training Act (VPETA). Together the three partners ensure a high level of quality of VET/PET programmes and an adequate number of apprenticeships for VET students and traineeships for PET students.

The Confederation (OPET) is mainly responsible for developing and ensuring the quality of the entire VET/PET system as well as for ensuring that courses are comparable and transparent throughout Switzerland.

The Cantons are responsible for implementing and supervising the VET/PET system. Each of the 26 Cantons therefore has its own VET/PET agency. Cantonal activities specifically include creating vocational schools and introducing VET programmes in these schools, providing advice to the parties to apprenticeship contracts (VET students and host companies), and drawing a sufficient number of companies willing to offer paid VET apprenticeships.

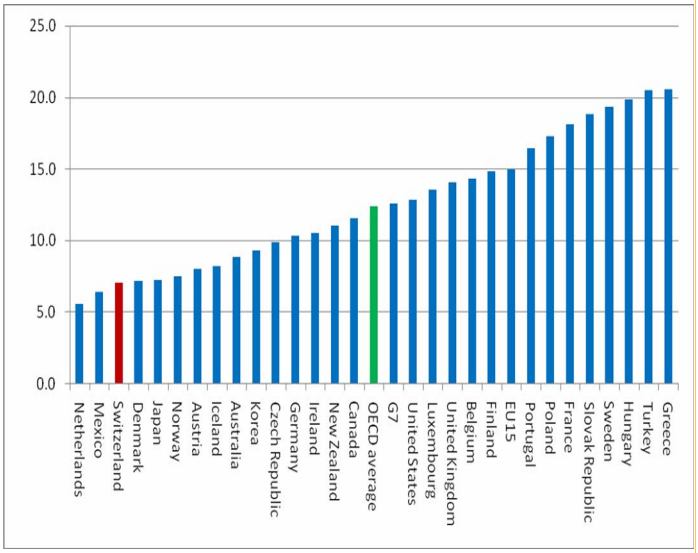
Professional organisations (which include trade associations, social partners and other organisations and VET/PET providers) are responsible for establishing and updating the content of VET and PET programmes. This ensures that the education and training programmes correspond to economic requirements, match the competencies needed and take into account the actual number of jobs available on the labour market. Professional organisations work with the Federal Office for Professional Education and Technology (OPET) and the Cantons on legislation and enactment of VET ordinances.

Companies provide VET apprenticeships and PET traineeships, thereby ensuring the next generation of qualified workers. Apprenticeships and traineeships provide students with practical training. In order to formalise the in-company training relationship, apprenticeship contracts are signed by VET students and the host company. Legally binding, these contracts must remain in effect for the entire duration of the VET programme. In almost every respect, apprenticeship contracts are equivalent to work contracts. The only difference is that apprenticeship contracts include a clause whereby the host company agrees to provide the student with practical training. The apprenticeship contract also sets forth the salary conditions for the entire period of training. The involvement of the companies in VET/PET programmes is voluntary.

Vocational schools are also important players within the VET sector of the VET/PET system. Vocational schools that provide school/work-based VET programmes handle the school-based training segment, which covers both vocational instruction and general education courses.

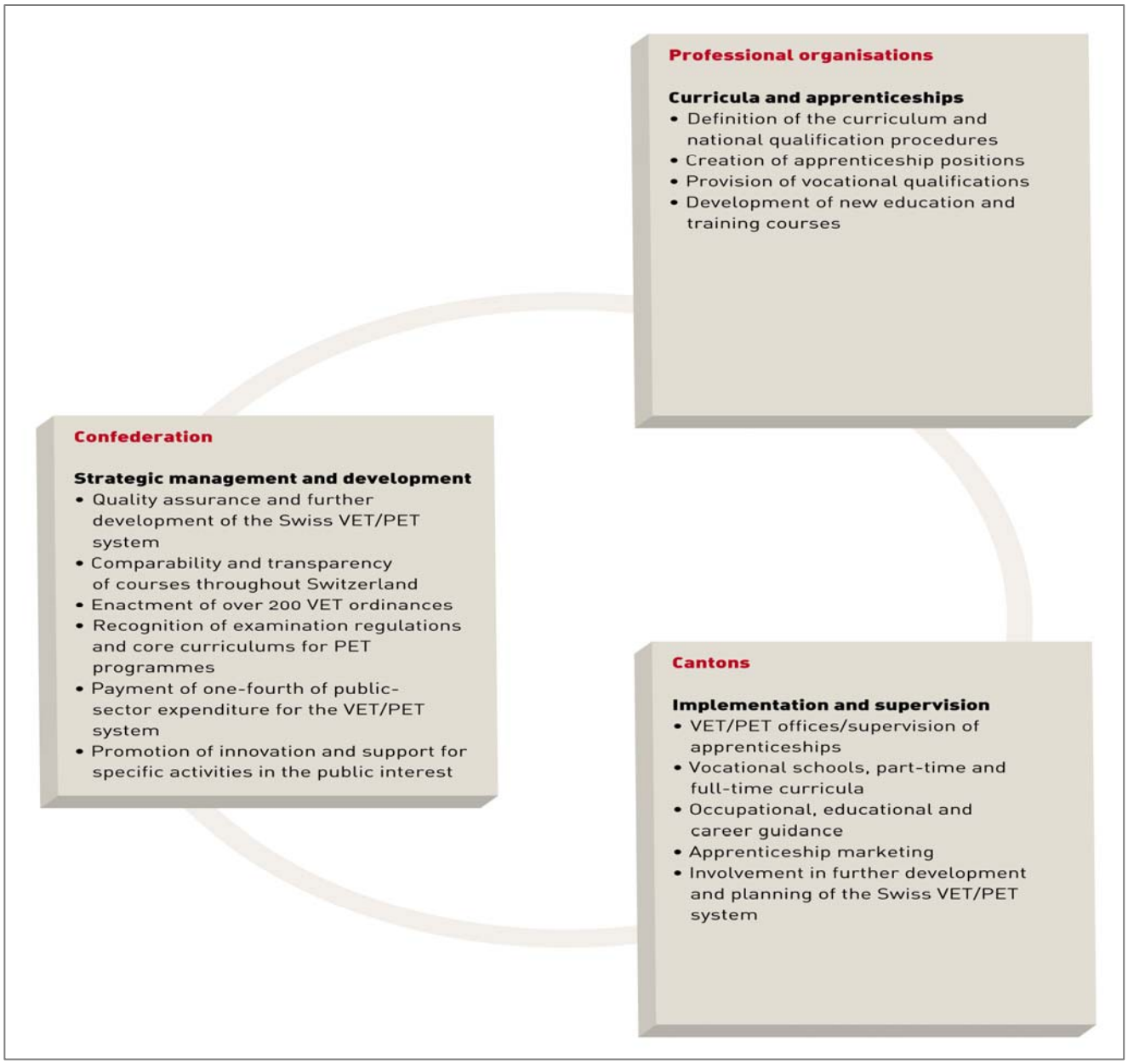
Efficient cooperation with VET/PET partners takes place within the following four federal standing commissions:

Figure 4: Youth unemployment under 25 years (OECD 2009)



Source: OECD in figures 2009 (reference year 2008)

Figure 5: VET/PET Partners



Source: OPET (2009): Facts and Figures. Vocational and professional education and training in Switzerland. OPET, p.6 - 7

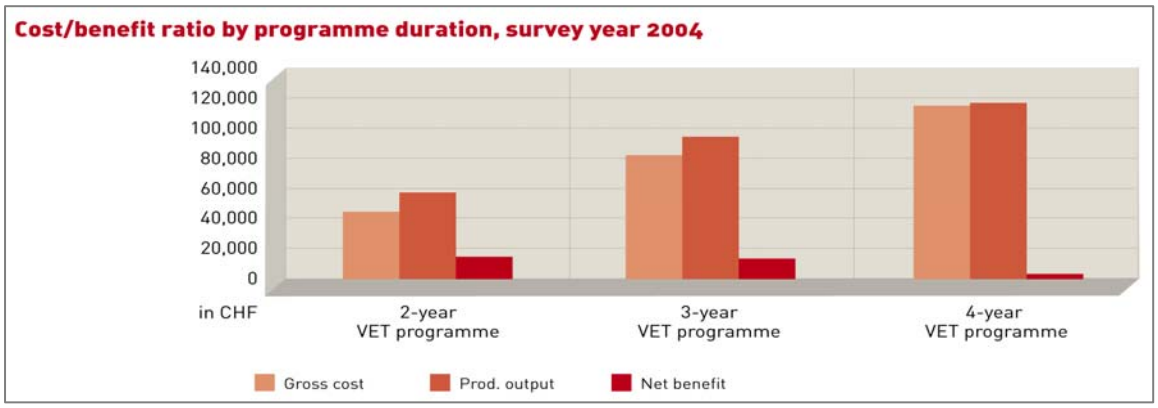
Federal Commission for Vocational and Professional Education and Training (EBBK), Federal Commission for VET Professionals (EKBV), Federal Vocational Baccalaureate Examination Board and Federal Commission for Professional Colleges.

Cooperation takes also place in three major national conferences every year: the VET/PET Conference, which is presided by the head of the Federal Department of Economic affairs (FDEA), the VET/PET Partner Conference and the OPET Conference in May. The Federal Office for Professional Education OPET organizes these conferences in order to enable discussion.

1.4 VET/PET Funding

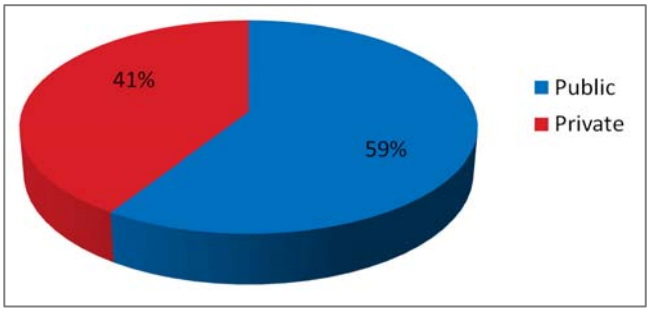
Switzerland's VET/PET system receives both public and private sector funding. On the public side, funding is provided by the Confederation, the Cantons and the Communes. The Cantons contribute the highest share of public funding. On the private sector side, funding comes from host companies, offering apprenticeships and traineeships, from trade associations, as well as from students and their families, who pay tuition and costs for education and training. Most of the costs for **professional education and training** are paid by students themselves, with a portion of these costs being paid by the students' employers. The figure

Figure 7: Cost and benefit



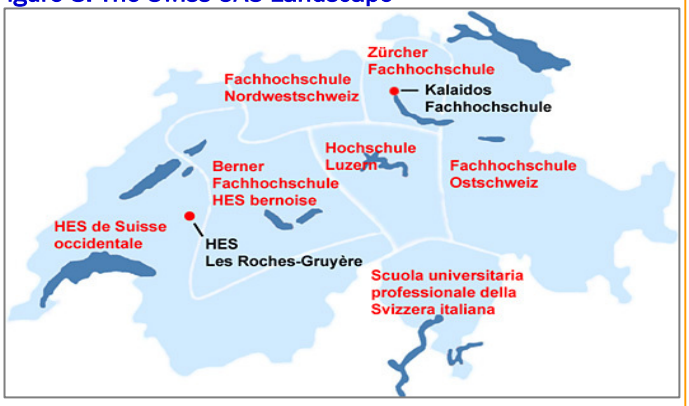
Source: OPET (2009): Facts and Figures. Vocational and professional education and training in Switzerland. Bern: OPET, p.19

Figure 6: VET Funding



Source: Federal Statistical Office and Mühlemann et al.

Figure 8: The Swiss UAS Landscape



OPET illustration

below shows the proportion of public and private expenditure for vocational education and training (VET). The public funding is around 59%. The private expenditure figure of 41% is an estimation and takes into account expenditure by companies but not by individuals (see Figure 6).

In 2004, host companies spent CHF 4.7 billion to train students enrolled in VET programmes.

Over the course of their apprenticeships, these students provided an economic output of CHF 5.2 billion. The cost/benefit ratio was positive for two-thirds of all host companies involved in VET programmes. For the remaining one-third that reported a negative cost/benefit ratio, the host companies in question often gained a short- to medium-term benefit by having to spend less money on such things as recruitment and orientation of new employees (see Figure 7).

For the 2008-2011 budgetary period, a total of CHF 270 million has been set aside for development of the VET/PET system. This corresponds to roughly 10% of the Confederation's total 25% contribution to all public expenditure relating to the VET/PET system Confederation's total commitment in 2008 – 2011: CHF 2.7 billion).

For the period 2008 – 2011, CHF 20 million have been set aside in a separate budget for VET/PET research. OPET provides funding to seven Leading Houses. Each Leading House is managed by a university chair who conducts research on a specific aspect of the VET/PET system. In addition OPET has two other tools at its disposal: it can provide grants for VET/PET development projects run by third parties and it may also play a more active role by issuing specific research contracts for its own needs.

As the institution responsible for training VET and PET professionals, Swiss Federal Institute for Vocational Education and Training (SFIVET) ensures that research findings are adopted and applied in practice.

2 Universities of Applied Sciences

Universities of applied sciences provide practical education and training at tertiary A level. Universities of applied sciences act as a relay for holders of the Federal Vocational Baccalaureate (FVB), allowing them to raise their level of qualifications to university level. Unlike PET programmes, universities of applied sciences also focus on fundamental and applied research.

Switzerland has seven public and two private universities of applied sciences. Creation of the UAS system began back in 1996 when the Federal Act on universities of applied sciences (SR 414.71) came into effect. This led to a major overhaul of the professional education and training domain. Seven UAS were created out of 28 engineering colleges, 21 economics and management colleges and 9 design colleges. Previously, all of these colleges provided tertiary level type B education and training and their legal basis could be found in legislation on professional education and training. After these colleges were merged into the UAS domain, their status changed from tertiary level B to tertiary level type A. This, alongside a general increase in student enrolment in tertiary level programmes, led to a significant shift in enrolment from tertiary level B to tertiary level A.

The Confederation and the Cantons work together to manage UAS system. Both are committed to maintaining the high quality of teaching and research at universities of applied sciences and to providing the best conditions for further development of the system. The Confederation is represented by the Federal Office for Professional Education and Training (OPET).

In Switzerland, the seven public and two private UAS provide education and training in challenging occupational fields that require scientific or artistic knowledge and a mastery of corresponding methods. There are study programmes in fields like technology, business, design, social work and art. Compared to Switzerland's cantonal universities and its two federal institutes of technology (FIT) in Zurich and Lausanne, UAS are more oriented towards practical aspects. Like the cantonal universities and the federal institutes of technology (FIT), UAS are based on the Bologna system. UAS do not, however, have the right to issue PhDs.

UAS are currently faced with a number of challenges; these include the ongoing reform process resulting from the Bologna Declaration, positioning of UAS in Switzerland's higher education landscape and the international context, expanding applied research and development activities and closer networking with the traditional universities and the federal institutes of technology (FIT). Courses in the fields of technology, economics, design, health, social work and the arts will also be restructured to better meet today's needs.

3 Summary and Outlook

Switzerland's long tradition of upper-secondary level VET and tertiary level PET ensures optimal cooperation between the three main partners of the Swiss VET/PET system (Confederation, Cantons and professional organisations). Some of the strong features of the VET/PET system include the following: cooperation between the three main partners and the combined school/work-based approach, which ensures that the content of VET and PET programmes closely match the needs of employers and the labour market; the Swiss education system is highly permeable in the sense that students may transfer from one segment to another (e.g. type B to type A programmes and vice versa) with relative ease; the ability of the Swiss VET / PET system to quickly adapt to new labour market conditions. In addition, qualified workers may be trained both at upper-secondary and tertiary level. These features enable the Swiss VET/PET system to bring a "skill-grade-mix" (i.e. ratio of specialised workers with upper-secondary and tertiary-level qualifications) that matches the needs of the labour market. In addition, students receive high-quality training, as attested by Switzerland's performance over the years at the WorldSkills Competition (ranking 2nd in 2009).

In the future, Switzerland will focus on bringing greater attention to its VET/PET system both within Switzerland and in other countries. Emphasis will be placed on combined school/work-based VET programmes. While the Bologna Process has enabled tertiary level type A qualifications to be recognised internationally, upper-secondary and tertiary level type B qualifications are hindered by a lack of transparency and/or recognition. The challenge is to create general conditions that will enable upper-secondary and tertiary level type B qualifications to be compared internationally, which should lead to greater mobility for the holders of such qualifications. In order to achieve this objective, Switzerland takes part in the Copenhagen Process, which seeks to bring permeability, transparency and mobility to VET and PET in Europe. Switzerland also strives to obtain mutual recognition of VET and PET qualifications in selected countries outside of Europe.

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3. Rolf Marti und René Grebasch (2009): "Wegbereiter der Berufsbildung war das Zunftwesen" (espace einsteiger 11.Februar 2009, www.espace.ch/einsteiger)

For additional information see:

Federal Office for Professional Education and Training (OPET)

www.bbt.admin.ch

Federal Statistical Office (FSO)
www.education-stat.admin.ch

Swiss Federal Institute for Vocational Education and Training (SFIVET)
www.ehb-schweiz.ch

Swiss Conference of Cantonal Directors of Education (EDK)
www.edk.ch

Portal for occupational, educational and career guidance
www.berufsberatung.ch

Swiss education server
www.educa.ch

Electronic VET/PET newsletter
www.panorama.ch

VET/PET Lexicon
www.lex.dbk.ch

OECD Learning for jobs
www.oecd.org/edu/learningforjobs

EDUCATION AS THE KEY TO LONG-TERM RECOVERY

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Summary

This year's edition of Education at a Glance (OECD 2009) is published at a time when all eyes are focused on addressing the financial crisis and its economic and social fallout. Presenting data up to 2007, the volume cannot yet assess the impact of the crisis on education systems, but its indicators provide important insights about how investments in human capital can contribute to the recovery. The report suggests that there is an urgent need in many OECD countries to review how the economic and social benefits and costs of higher education are shared between individuals and society. For example, the report found that countries in which students pay tuition fees for teritiary institutions do not show lower levels of access to university-level education than the OECD average. At the same time, there is no evidence that the promotion of 'free education for all' would contribute to more social mobility or less economic inequality.

Better qualifications or lower pay – a large and growing skills gap.

Education has always been a critical investment for the future, for individuals, for economies and for societies at large. The gross earnings premium for males from tertiary education over the working life averages USD 186 000 across OECD countries and exceeds USD 300 000 in Italy and the United States. When factoring in the direct and indirect costs for education, the net public return from an investment in tertiary education averages USD 52 000 on average for a male student. This is almost twice the amount of the investment made by the public side (including both public direct costs and public forgone revenue), and as such, provides a strong incentive to expand higher education in most countries through either public or private financing. Furthermore, among the 30 OECD countries with the largest expansion of college education over the last decades, most still see rising earnings differentials for college graduates, suggesting that the increase in advanced qualifications has not necessarily led to a decrease in their pay as has been the case in many countries for individuals with less than upper secondary education.

The incentives for individuals to stay on in education are likely to rise over the next years given the economic environment: For instance, because the opportunity costs for education decline as the difficulties of finding employment increase and opportunity costs or lost earnings while studying tend to be the largest of all cost components for students (except in the United States where tuition fees are highest) job prospects have a real influence on young individuals decision to continue their education.

Earnings foregone depend, of course, on the wage levels one can expect to receive and most notably the probability to find a job. At a time where the labour market for young adults is likely to deteriorate in the coming years, forgone earnings and thus total costs will fall and thereby also increase the returns for tertiary education. The incentives to invest in education both from the private and public perspective will thus be further advanced across most OECD countries.

The volume of educational activity has been expanding rapidly over the past decade.

The share of people participating in education beyond compulsory schooling has grown from a small minority to the vast majority. This expansion continues, as near-universal participation at upper-secondary level is followed by ever-wider enrolment in tertiary-level institutions. The number of individuals that have attained tertiary education has increased, on average, by 4.5% each year since 1998, and by 7% per year or more in Ireland, Poland, Portugal, Spain, and Turkey. In 2007, one-third of the youth cohort (25-34 year-olds) had attained a tertiary level qualification and in some countries (Canada, Japan, Korea and the partner country the Russian Federation), over 50% of the youth cohort have. This implies that overall tertiary attainment levels will continue to rise in the coming years. In France, Ireland, Japan and Korea, there is a difference of 25 percentage points or more in the tertiary attainment of the oldest and youngest age cohorts.

Increases in tertiary graduation rates have been particularly marked over the last decade. On average across OECD countries with available data, university-level graduation rates have virtually doubled from 20% in 1995 to 39% in 2007. As the pace of change has differed widely across countries, the relative standing of countries on this measure has changed dramatically since 1995. At one end of the spectrum, Finland improved its relative performance

from Rank 10 in 1995 to Rank 3 in 2007. Conversely, the United States dropped from Rank 2 in 1995 to Rank 14 in 2007.

The other good news is that, with the exception of Germany, Japan, Mexico, Poland, Turkey and the United States, the number of individuals available to the labour market with below secondary education, that is the share of the most poorly qualified, decreased between 1998 and 2006, in some countries by very small amounts but in others substantially so. While the labour-market prospects for these individuals remain poor and deteriorating, at least their numbers have declined.

Tertiary educated young individuals in the Czech Republic, Hungary, Iceland, Luxembourg, the Netherlands, and the Slovak Republic and in the partner country Slovenia continue to have good prospects of finding a skilled job. In these countries, 85% or more of tertiary educated 25-34 year-olds are employed in skilled occupations, indicating that those with higher education are in strong demand. Since 1998, young tertiary educated individuals in Austria, Finland, Germany and Switzerland have improved their prospects of finding a skilled job. At the same time, young workers without a tertiary education appear to have a good chance relative to older workers in finding a skilled job, indicating a potential gap between supply and demand of high-end skills in these countries.

In countries without significant household spending on tertiary education, declining opportunity costs can strengthen the case for more household investments because, as the more educated individuals have a stronger attachment to the labour market, this increases the benefits of education. Conversely, in countries where significant house spending may be a barrier for increasing student participation, additional public spending may leverage additional participants and thus additional public benefits. Last but not least, graduating and entering the labour market in an economic downturn can be expected to become more difficult, as employers cut jobs and young graduates compete with more experienced workers.

Early childhood education has been another area where significant progress has been achieved.

The expansion of education systems has been very dynamic also in early childhood education. While in 1996 there were, on average across OECD countries, 41% of children four years and younger as a percentage of 3 to 4 year-olds enrolled in educational institutions, in 2007 it was 71%. In fact, in Austria, Denmark, Spain, Norway, Korea, Portugal, Germany, Switzerland, Finland, Sweden, Poland and Mexico this proportion more than doubled over this period. In Sweden, for example, enrolment in early childhood education stood at 40% in 1996 while in 2007 it was, at 98%, virtually universal. In contrast, in New Zealand, Greece, Iceland, Ireland, Australia, France, the United States and the Netherlands the growth rates remained below 50%, although in New Zealand, Iceland and France this is mainly explained with enrolment being close to universal already in 1998. In half the OECD countries, enrolment in early childhood education is now 80% or higher.

Important equity-related considerations which arise from the deteriorating job prospects for the less-well qualified.

While enrolments for 15-19 year-olds have been steadily rising in most countries, this still leaves an important minority who leave education without acquiring a baseline qualification. Across OECD countries, 42% with less than an upper secondary qualification are not even employed. Even those with higher levels of education are vulnerable if they become unemployed. Young people with lower qualifications who become unemployed are also more likely to spend a long time out of work: in most countries over half of low-qualified unemployed 25-34 year-olds are long-term unemployed. In contrast, as noted before, those in work enjoy high wage premiums for completing tertiary education – over 50% in most countries.

Opportunities for continuing education and training are often designed to make up for deficiencies in initial education, but the data suggest that participation among individuals with strong initial qualifications is significantly higher than among the least qualified, such that these opportunities often do not reach those who need them most.

Moreover if the demand for education and qualifications continues to rise as labour market prospects weaken, the gaps in educational attainment between the younger and older adult cohorts are likely to widen further. The vulnerability of older, often less qualified, adults to chronic long-term economic inactivity may thus become more acute. In contrast with much higher levels of educational participation among those in their twenties, less than 6% (5.9%) of the 30-39 year-old population across OECD countries are enrolled full- or part-time. While in some countries it is significantly higher than this, at more than 1 in 10 (Australia, Finland, Iceland, New Zealand and Sweden), in others participation is less than 3% of 30-39 year-olds (France, Germany, Korea, Luxembourg, the Netherlands, and Turkey and partner country the Russian Federation), with even lower levels for over 40s in Austria, the Czech Republic, France, Germany, Hungary, Ireland, Italy, Korea, Luxembourg, Mexico, the Netherlands, Portugal, the Slovak Republic, Switzerland, Turkey and the partner coun-

tries Chile, the Russian Federation and Slovenia. With lifelong learning more essential than ever, public policy needs to ask how adequately education and training systems are addressing the learning needs of older adults who are in need of new skills.

As far-reaching as the labour market impacts of the crisis are, the potential social consequences may last even longer.

The data on the economic outcomes of education are this year complemented by a new indicator on social outcome. The focus is on three aspects that reflect the health and cohesiveness of society: self-assessed health, political interest and interpersonal trust. All of these social outcomes have a positive relationship to educational attainment, but they differ in terms of which level appears to confer the greatest advantage. Students who complete upper secondary education are much more likely to report good health than those who do not. Increase in political interest and the belief that most people try to be fair are in contrast more related to the attainment of a tertiary level of education.

For self-reported health, an increase in educational attainment from below-upper secondary to upper secondary level is associated with a stronger and more consistent increase in health outcomes, compared to an increase in educational attainment from upper secondary to tertiary level, in all surveyed countries except Poland. For political interest and interpersonal trust, an increase in educational attainment from upper secondary to tertiary level is broadly associated with stronger and more consistent increases in social outcomes, compared to an increase in educational attainment at the lower level.

The association between educational attainment and social outcomes generally weakens after controlling for household income, suggesting that income is one pathway to explaining this relationship. However, in most countries, the association between education and social outcomes remains strong after adjusting for household income. Hence, what individuals potentially acquire through education – e.g. competencies and psycho-social features such as attitudes and resilience – may have an important role in raising social outcomes, independent of education's effect on income.

Opportunities for work-based vocational education and training is at risk

At a time when it is so important to invest in knowledge, skills and capacities that are relevant to economies and societies, particular pressures will be faced in those systems which rely on a major component of work-based training as part of vocational education and training at the secondary or tertiary levels. Companies struggling to cut costs and avoid lay-offs may well find it increasingly hard to place trainees. Systems are not in the same position in this regard: in many, only a small number of months are spent by 15-29 year-olds on average in both education and employment combined. But in some, to be "in education" means to be simultaneously "in employment" for many young people, including on work study programmes. In Denmark, Germany, Hungary, Ireland, Switzerland and the partner country Estonia, around 75% of upper secondary students are in vocational programmes which combine school- and workbased elements. In Australia, Denmark, Iceland (in the case of women only), the Netherlands, Switzerland and the United Kingdom (women only), more than half of the time in education between ages 15 and 29 will have the double status combining it with employment.

Public and household spending on education is being scrutinised.

OECD countries as a whole spend 6.1% of their collective GDP on education, all levels combined. In Denmark, Iceland, Korea, the United States and the partner country Israel, it is over 7%. As a share of total public expenditure, the 2006 OECD average for education stood at 13.3%, ranging from less than 10% in Germany, Italy and Japan to the far higher figure of 22% in Mexico.

Expressed on a per-student basis OECD countries spend, on average, USD 93 775 per student over the duration of primary and secondary studies, ranging from less than USD 40 000 in Mexico and the Slovak Republic, and the partner countries Brazil, Chile and the Russian Federation, to USD 100 000 or more in Austria, Denmark, Iceland, Ireland, Italy, Luxembourg, Norway, Switzerland, the United Kingdom and the United States (all figures are corrected for cross-country differences in purchasing power).

It is noteworthy that expenditure per student on primary and secondary schools increased in every country, on average, by 35% between 1995 and 2006, a period of relatively stable student numbers. The pattern is different at the tertiary level where spending per student has fallen in one third of OECD and partner countries; expenditure has not kept up with the expansion in student numbers.

At the tertiary level, expenditure on educational institutions per student increased by 11 percentage points between 2000 and 2006 on average in OECD countries after having remained stable between 1995 and 2000. This shows governments' efforts to deal with the expansion of tertiary education through massive investment. Five out of the 11 countries (the Czech Republic, Mexico, Poland, the

Slovak Republic and Switzerland) in which student enrolments in tertiary education increased by more than 20 percentage points between 2000 and 2006 increased their expenditure on tertiary educational institutions by at least the same proportion over the period, whereas Hungary, Iceland, Ireland and the partner countries Brazil, Chile and Israel did not.

Countries vary not just in how much they spend on education, but also in how they spend their money.

The case for education's role in the recovery will require a demonstration that education is capable of transforming itself to improve outcomes and value for money. It is difficult to establish the right combination of well-trained and talented personnel, appropriate instructional time and material, and adequate facilities. However, the new indicators shed some light on this by examining the choices countries make when investing their resources in primary and secondary education, such as trade-offs between the hours that students spend in the classroom, the number of teaching hours of teachers, class sizes (proxy measure), teachers' salaries and the proportion of teacher's working time that is devoted to teaching.

First of all, salary cost per student at upper secondary level varies significantly between countries, from 3.6% of GDP per capita in the Slovak Republic (less than half of the OECD average rate of 11.4%) to over six times that rate in Portugal (22%, nearly twice the OECD average). Four factors influence these differences – salary level, instruction time for students, teaching time of teachers and average class size – so that a given level of salary cost per student can result from many different combinations of the four factors. As a result, similar levels of expenditure among countries in primary and secondary education can mask a variety of contrasting policy choices. For example, in Korea and Luxembourg salary costs per student as a percentage of GDP per capita is both around 15% at the upper secondary level. However, while Korea uses very large class sizes to pay high teacher salaries, finance above-average instruction time for students and provide teachers with time for other things than teaching, Luxembourg has invested most of its resources into small class sizes, at the expense of below-average instruction time and salaries.

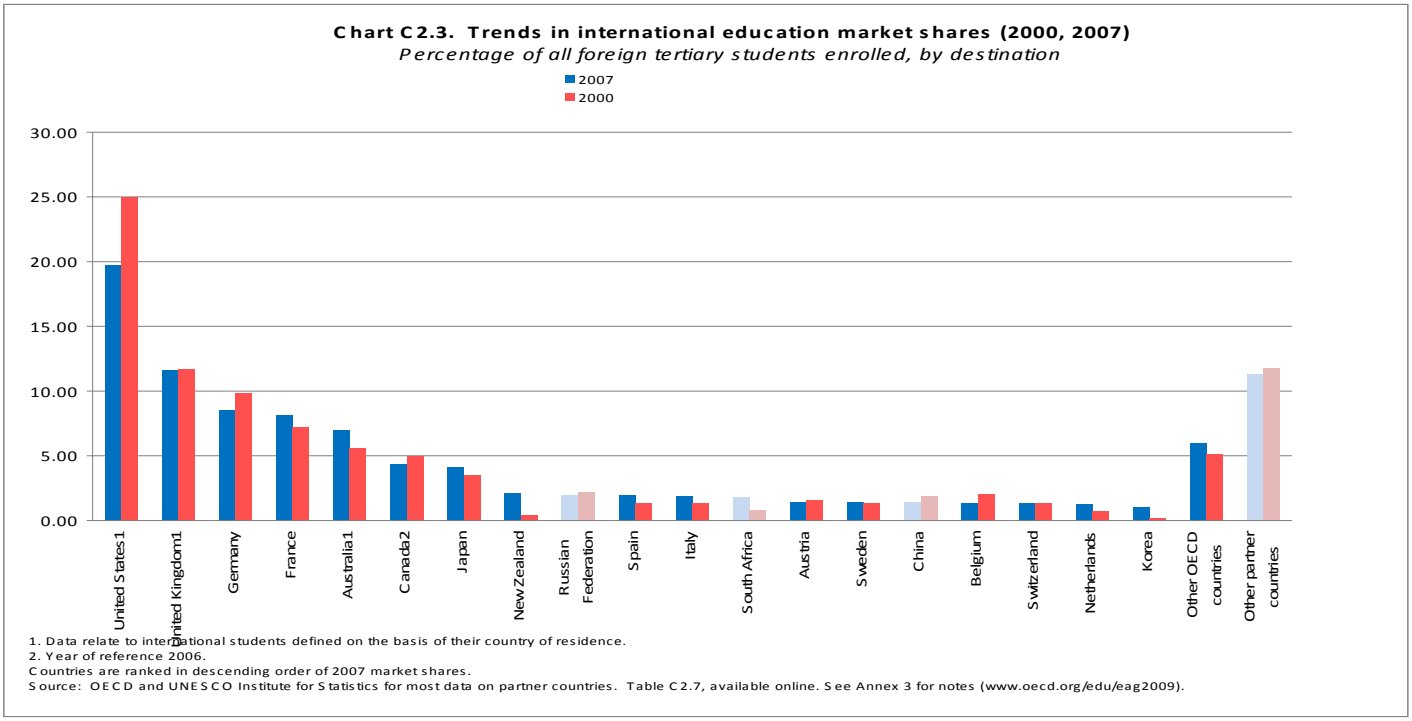
Effective cost-sharing between participants in the education system and society as a whole

Cost-sharing is especially relevant for pre-primary and tertiary education, for which full or nearly full public funding is less common. As new client groups participate in a wider range of educational programmes and choose among more opportunities from increasing numbers of providers, governments are forging new partnerships to mobilise the necessary resources for education and to share costs and benefits more equitably. As a result, public funding more often provides only a part (albeit a very large part) of investment in education, and the role of private sources, mainly through households, has become more important. Some stakeholders are concerned that this balance should not become so tilted as to discourage potential students to access to tertiary education. Thus, changes in a country's public/private funding shares can provide important information on changing patterns and levels of participation within its educational system. Indicator B3 shows that while in all countries for which comparable data are available public funding on educational institutions increased between 2000 and 2006, household spending increased at an even greater rate in nearly three-quarters of these countries, even if in 2006, 85% of expenditure, on average, for all levels of education combined, was still from public sources.

On average among the 18 OECD countries for which trend data are available, the share of public funding in tertiary institutions decreased slightly from 78% in 1995 to 76% in 2000 and to 72% in 2005 and 2006. This trend is mainly influenced by non-European countries in which tuition fees are generally higher and enterprises participate more actively by providing grants to finance tertiary institutions. However, the increase in household spending has gone hand in hand with increased public financing. Compared to other levels of education, tertiary institutions and to a lesser extent pre-primary institutions obtain the largest proportions of funds from private sources, at 27% and 19%, respectively.

...and one where countries differ in their approaches particularly when it comes to tuition

In the context of the debate of how the benefits and costs of education should be shared, decisions taken by policy makers on the tuition fees charged by educational institutions affect both the cost of tertiary studies to students and the resources available to tertiary institutions. It is noteworthy that OECD countries in which students are required to pay tuition fees and can benefit from particularly large public subsidies do not show lower levels of access to university-level education than the OECD average. For example, Australia (86%) and New Zealand (76%) have among the highest entry rates to university-level education, and the Netherlands (60%) and the United States (65%) are above the OECD average. The higher entry rates to university-level education in Australia and New Zealand are, however, also due to high proportion of international students. These two countries substantially increased their share in the international education market (see Figure 1). There are large differ-



ences among OECD and partner countries for which data are available in the average tuition fees charged by university-level public institutions. In eight OECD countries public institutions charge no tuition fees, but in one-third of countries with available data public institutions charge annual tuition fees for national students in excess of USD 1 500.Among the EU19 countries for which data are available, only Italy, the Netherlands, Portugal and the United Kingdom (government-dependent institutions) have annual tuition fees that represent more than USD1 100 per full-time student.

Concluding remarks

Governments are paying increasing attention to international educational comparisons as they search for effective policies that enhance individuals' social and economic prospects, provide incentives for greater efficiency in the provision of education, and help to mobilise resources to meet rising demands.

The general trend towards freely circulating capital, goods and services, coupled with changes in the openness of labour markets, has translated into growing demands for an international dimension of education and training. Indeed, as world economies become increasingly inter-connected, international skills have grown in importance for operating on a global scale. Globally oriented firms seek internationally-competent workers versed in foreign languages and having mastered basic inter-cultural skills to successfully interact with international partners. Governments as well as individuals are looking to higher education to play a role in broadening students' horizons and allowing them to develop a deeper understanding of the world's languages, cultures and business methods. From a macroeconomic perspective, international negotiations on the liberalisation of trade in services highlight the trade implications of the internationalisation of education services. Some OECD countries already show signs of specialisation in education exports. The long-term trend towards a greater internationalisation of education is likely to have a growing impact on countries' balance of payments as a result of revenue from tuition fees and domestic consumption by international students..

The internationalisation of tertiary education has many economic impacts, in addition to the short-term monetary costs and benefits that are reflected in current account balances. It can provide an opportunity for smaller and/or less-developed educational systems to improve the cost efficiency of their education provision. Indeed, training opportunities abroad may constitute a cost-efficient alternative to national provision and allow countries to focus limited resources on educational programmes for which economies of scale can be generated, or to expand participation in tertiary education in spite of bottlenecks in provision.

Acknowledgement

Based on the OECD (2009) Education at a Glance 2009. Paris (see www.oecd.org/edu/eag2009)

Science In the News

Cellphones team up to make Wi-Fi where you want it

Microsoft has built a system that knits together the internet connections of a collection of smartphones to create a high-speed wireless hotspot that computers can use when other connections aren't available.

The computers connect to the phones using short-range Wi-Fi, requesting web pages as if they were using a wireless router with a wired connection to the internet, and the cellphones use their long-range cellular connection to get the files requested from the net.

Crucially, the system, dubbed Cool-Tether, coordinates the phones to send data in fewer, longer bursts, and to make sure that each "energy tail" is associated with as much data transfer as possible. Cool-Tether uses a quarter as much energy as the previous version of the system, with little loss of downloading speed.

Srinivasan Keshav of the University of Waterloo in Ontario, Canada, says Cool-Tether incorporates "some neat ideas, [including] burst transmission and a careful analysis of energy". However, it's not clear how practical it is today, he argues, because Wi-Fi-enabled cellphones are not yet that common.

For details see: New Scientist.

African Initiative Trains Students, Explores Geophysical Mysteries

Earthquakes, volcanoes and the African superplume are only some of the phenomena under investigation through AfricaArray, a program that establishes geophysical observatories, trains African and American students and examines geophysical phenomena on the African continent.

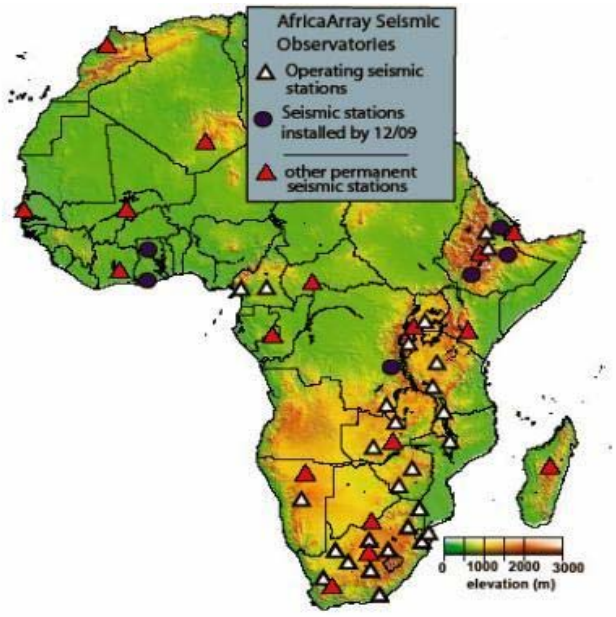
The model, created by a trio of institutions -- Penn State; University of the Witwatersrand, Johannesburg, S.A., and the Council for Geoscience (S.A.) -- combines student education with establishment of a research program in geophysics; field schools attended by African and American students and corporate personnel, and a graduate exchange program.

The center of the program is the research that relies on data from a network of seismic observatories: 27 installed by AfricaArray, 6 that should be installed by the end of the year and 16 other seismic observatories. The program also employs temporary targeted networks of stations for specific, higher resolution problems and currently has networks in Angola, Botswana and Namibia exploring the Congo Craton; South African gold mines looking at small, deep seismic events, and in Uganda/Tanzania for imaging the African Superplume. Data from the stations is stored with the Incorporated Research Institutions for Seismology (IRIS), a university research consortium sponsored by the National Science Foundation.

So far, after three years, AfricaArray has supported 34 undergraduate, 13 masters and 10 doctoral students. They have also hosted five postdoctoral fellows. From the U.S. side, 12 students, half of them women, have participated in three-week geophysical summer programs to South Africa from North Carolina A&T State University; Fort Valley State University, Georgia; University of Texas, El Paso, and California State University, Northridge. Graduate students from Wits have also come to the U.S. to study under Penn State faculty co-advisors.

Plans for the future include expansion of seismic observatories into West Africa and eventually North Africa as well. They are currently working with two other African universities -- Agostinho Neto in Angola and Addis Ababa University in Ethiopia -- to include the program in their universities. The researchers would like to see installation of additional types of sensors and monitors including meteorological, environmental and geographic positioning system instruments, noting that once the infrastructure is there for the seismic observations, it is easier to collect data in other disciplines.

Map of Africa showing permanent seismic observatories associated with AfricaArray.



HUMANIST EDUCATION AS A TOOL OF EMPOWERMENT

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Abstract

This article argues that the current global economic downturn also represents a crisis in discipline-oriented academic thinking, especially in the areas of ethics and economics. These two disciplines are still largely based on rationalist and idealist views of the human being and therefore incompatible with the real nature of the human being as revealed by recent research findings in anthropology, neuroscience and experimental psychology. As a result, policy makers as well as educators are likely to increase their interest in humanist education, which regards individuals as social beings that must learn to live in two worlds with different rules; the world of the community that is ruled by the informal rules of fairness and reciprocity and the world of society at large in which people tend to pursue their self-interest. National education systems must prepare future generations to serve the needs of their communities as well as to thrive within the complex rules of the market economy and democracy. In this context, it is important to recognize that community identity can only survive by embracing cosmopolitan values that ensure connectivity and exchange with the larger social environment. This will be illustrated by discussing the education system of Florence in Renaissance Italy and comparing it with education initiatives in today's successful emerging economies. The rediscovery of humanist education may also lead to national economic and cultural empowerment through endogenous growth in Africa.

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Keywords: Interdisciplinarity, food crisis, economic theory, Humanism, South–South collaboration, Renaissance Italy

1. Introduction

1.1 The crisis and what it reveals about the academic system

The food crisis and the subsequent financial crisis of 2008 reveal an intellectual crisis in academia that has grown steadily since the end of the Cold War. Institutions that were originally designed to serve the people have changed into large self-contained systems of thought that have developed their own internal logic and thus become increasingly concerned with their own survival and expansion. Simone Weil called this phenomenon 'the great beast' that is intrinsic to every form of evolving social organization [1] and Joseph Schumpeter recognized it as the great curse for entrepreneurial capitalism [2]. However, once these self-contained systems become part of the problem rather than part of the solution to contemporary challenges, new opportunities for intellectual renewal may emerge. That said, policy strategies pursued before and after the crisis year of 2008 still reflect ideas that have their roots in the 1970s, ignoring the reality of the global knowledge economy and new insights from recent empirical interdisciplinary research.

It is therefore not surprising that the bureaucracies in business, government, academia and civil society are mostly in denial about their particular responsibility for the crisis and are engaged in ex-post rationalizations of their policies and recommendations prior to the global crisis.

1.2 The case of the food crisis

When world market prices for major food and feed stocks rose to previously unheard of levels in spring 2008, the situation caused violent protests among the poor in many large cities of the developing world. Their tight household budgets were no longer sufficient to cover the basic expenses for food. This development took policy makers across the globe by surprise because it was widely assumed that the trend of declining food prices over the past decades would continue due to technological progress and the fact that, in economic terms, basic food is characterized by low income elasticity (the share of food expenses in household budgets normally decreases with increasing income).

When it came to staving off the food crisis, governments largely used conventional policy recipes based on neoclassical welfare economics. They imposed export restrictions and approved the expansion of cultivated land to ensure the national public good of food security – mostly at the expense of food importing countries, which had to deal with even higher food prices on the world market. The same lack of originality can be observed in a recently published influential report called *International Assessment of Agricultural Science and Technology for Development*

(IAASTD) [3], which supports the large NGOs and academics in affluent society who advocate a return to traditional agricultural methods and food sovereignty. Like many traditional welfare economists they seem unable to spot any potential new technologies that might be useful in addressing the basic problems of food crises.

Many of them were trained back in the 1970s on comparative-static neoclassical economic theory [4] and dualist theories of underdevelopment (e.g. dependence theory, structuralist theories) [5] that are unable to explain the complex, messy and dynamic reality of today's knowledge economy; yet they continue to shape university curricula and public policies [6].

By claiming that the food crisis is a result of unfair distribution rather than low local food production capacity, many of these conventional 'experts' indirectly endorse a sort of food aid that is akin to food dumping (food surpluses in industrialized countries are to be freely distributed in developing countries) and ignore the importance of combining existing local knowledge with selected and tailored new technologies in addressing not only agricultural but also environmental problems. By insisting on approaches that may be in line with old theories but which have proved to be ineffective and impractical in the real world, their claims reveal a lack of moral sensitivity towards the often voiceless poor who are affected by their false advocacy and a preference for the cherished world views and prejudices of their own affluent constituencies. Taking into account recent insights in neuroscience and evolutionary psychology [7], one might argue that our brains have evolved a strong capacity not to empathize with those in such different circumstances. Yet, in a globalized world, sustainable survival strategies increasingly require us to empathize and socialize with people who do not share the same culture and belief systems.

The reality on the ground, particularly in Africa, has worsened considerably over the past decade. Sub-Saharan Africa has become more dependent on food aid than ever before [8]. One reason for this misery might be the continent's strong ties to its former colonial masters in Europe and the high economic dependence on aid and European market access for agricultural goods. This has made African governments more prone to adopt policy prescriptions from Europe that were based on outdated but imperial knowledge that lacked a proper understanding of the local context [9].

The food crisis of 2008 should nevertheless undermine such neocolonial development strategies, especially considering that, for more than a decade, South–South collaboration within the developing world is growing much faster than North–South collaboration [10]. South–South collaboration is less concerned with standards and regulations to preserve cultural identity and more on facilitating sustainable change through investment in cultural, economic and technological exchange. Its primary purpose is to jointly address economic and social problems, by investing in local people and jump-starting joint research and development programmes designed to promote home-grown technological development with significant spillover effects for the local economies [11].

It may be that South–South collaboration is not addressing the problems that are high on the priority list of Europeans and Americans – and still depends on many valuable North–South links, but South–South networks are often far more pragmatic in their approach and thus more effective in meeting the goals they intend to achieve. Furthermore they do not have to worry about pleasing the people back home as is the case with many donor agencies, NGOs and supermarket chains based in Western countries and they are generally less ideological. They simply cannot afford to waste money by organizing countless local workshops in the name of 'capacity building' (a term that frequently serves to impose foreign views on local people) and then call it 'empowerment' or 'help for self help'. With the global economic downturn and the urgent need to effectively address the global environmental challenges, the justification for such expenses may also have to be revisited by European donors. There is a need to focus more on the priorities of the poor and to take more seriously what they consider to be major problems and how these ought to be addressed. This is of course a challenge, not least because the aid-dispensers often feel that they know best due to the academic education they have received in their home country. Frequently, and mistakenly, they also attribute the deferential treatment they receive in host countries in Africa to their 'superior' education rather than to the fact that their visit might bring money. Not surprisingly, aid-recipients are often willing to agree with everything proposed as long as aid money is dispensed. Yet, once international donors realize that the best ideas in development practically never come from idealists in Europe or the US but rather from local practitioners in developing countries themselves, they might change their minds. Put simply, the major difference is that while Western idealists see the problems and want to solve them by changing the system, local practitioners see the opportunities within the existing system and want to realize them. The global knowledge economy does indeed offer many opportunities for local people to combine their practical local knowledge with the use of new technologies that are sufficiently affordable and flexible to contribute to tailor-made solutions. In this context, it is not important whether the good or service is produced in the South or the North, or in the private sector

or the public sector, so long as it is useful and applicable. These are lessons that can be learned from the pragmatic approach in South–South research collaborations where stakeholders have learned from experience that the only non-scarce resource, and the only resource that is not depleted with increasing use, is knowledge. Therefore major investment needs to go into the production and use of knowledge that is of practical relevance. This means investing in human capital and the mobilization of science and technology for cost-effective technological innovations that foster economic development and a more sustainable use of natural resources. In this endeavour, we should abandon our cherished antagonisms in which one has to take sides between small-scale and large-scale agriculture, traditional knowledge and new technologies, public sector activities and private sector activities, to name but a few. In the face of the urgent need to address the complex problems related to hunger, malnutrition, environmental degradation and economic development it is pointless to cling to such dualistic worldviews if they do not produce tangible results. Yet, since the dualist mode of thinking still prevails in the teaching of economics and ethics in Western institutes of higher education it is unlikely to disappear any time soon from affluent societies, even though it was part of the reason for the global financial crisis which began in the autumn of 2008.

1.3 The financial crisis and the subsequent economic downturn

It may be a coincidence that the food crisis and the financial crisis occurred in the same year, but both crises are rooted in same flawed comparative-static equilibrium models that ignore the evolutionary character of every economic system [12] as well as the fact that it is unconscious or bodily thinking rather than the rational conscious mind that is responsible for most human decision-making [13]. These "animal" spirits account for the often messy decision-making process of economic agents [14]. They were still taken into account by the great economists in the early 20th century but have since somehow disappeared from the mainstream textbooks on economic theory.

For many decades, general equilibrium (GE) models are applied by agricultural economists working in institutions such as the World Bank and macroeconomists working in central banks. These economists mostly worried about the prices of goods and services while they neglected the prices of assets, trusting the financial markets to assess them properly. Consequently, in such GE models, bankruptcy cannot occur because financial intermediaries such as banks do not appear in the model. Convenience led economists to abide by these models, believing that what does not appear in the model must be irrelevant [15].

The academic discipline of financial economics, in particular, seemed to espouse almost a religious faith in models that assume purely rational economic agents. Most of these models are based on the efficient-market hypothesis (EMH) developed by Eugene Fama in the 1970s at the University of Chicago. The EMH argued that the price of a financial asset always reflects all available information that is relevant to its value. Wall Street then concluded that markets would automatically price financial assets accurately. Deviations from equilibrium values would be quickly detected by the rational investor who made money by exploiting the deviation by means of the various financial instruments available. The theory was that such rational investors would also quickly detect a bubble and prick it before it grew out of control. In the current climate it is no longer necessary to rebut these assumptions in view of the fact that its flaws have already been revealed through the financial crisis. But we should not lose sight of the fact that most public policy instruments today are still based on the idealist view of a purely rational and cognitive human being.

In short, both the food crisis and the financial crisis revealed that the economic models that rely on a purely rational economic agent may do more harm than good in public policy. The human being is guided by a dynamic belief system that largely reflects life experience as well as internalized knowledge acquired from different sources. The narrow view of the human being as a human oeconomicus driven exclusively by material self-interest and stable individual preferences contradicts all insights from experimental psychology [16]. Moreover, the human being is generally not a passive observer but one actively engaged in pattern recognition and storytelling to make sense of this world and find opportunities to make a living [12].

2. Reconsidering the theoretical foundations of Humanism

Humanism is the term generally applied to the predominant intellectual and literary currents of the period from 1400 to 1650 in Europe. It has its roots in Italian Renaissance and the age of exploration that lead to a revival of business, arts and science. In this period prior to Enlightenment, the great scholars did not yet separate inductive research (moving from specific to the general) from deductive research (moving from the general to the specific) and they did not regard ethics as being *per se* opposed to the pursue of self-interest. They embraced instead a

more holistic approach to research and ethics that was not yet characterized by a dualist mindset. This more holistic approach pursued in the age of humanism is being rediscovered today thanks to many new empirical insights on revealed human behavior and decision-making that are in line with humanist philosophy.

2.1 How ethics and economics have lost touch with real human nature

The deductive approach preferred by neoclassical economists starts from the premise that the human being is a rational utility maximizer. This generally accepted principle would allow economists to logically deduce human behavior in real life. This deductive logic does however not permit changes in theory that might undermine its fundamental assumptions. It would threaten the platonic beauty of the comparative static equilibrium models in economics. Even though the predictions of these models turned out to be inaccurate or simply wrong, there were always explanations are at hand, at least before the economic downturn, to explain away inconsistencies as a sort of noise [15].

Behavioral economists and political economists, who are generally less attached to neoclassical theory and its equilibrium models, have shown increasing interest in the basic insights obtained from research in experimental psychology and the neurosciences. They have also introduced a more inductive approach by designing controlled laboratory experiments.

Their findings largely confirm what has already been inferred from insights gained in the cognitive sciences: people may pursue their self-interest but they also have other-regarding preferences that often keep them from maximizing their immediate material benefits. Experiments on cohorts of student volunteers from across the globe seem to confirm a universal preference for fairness and reciprocity in different economic games [17]. Yet, rather than using evolutionary economics and attempting to explain these other-regarding preferences as innate human instincts that evolved during the period of hunter–gatherer communities to facilitate effective cooperation in small communities, behavioural economists tend to attribute it to another form of rationality. This rationality is supposedly related to universal ethical principles and notions of justice and fairness rather than economic principles (19). This idealist assumption resembles Kant's view that the real value of a moral act can only be seen in the categorical absence of personal desires and interests. It is also strongly connected to the theory of the stages of moral development developed by Lawrence Kohlberg in the 1970s and defines the highest stage of moral reasoning in accordance with the purely cognitive and reason-based view of de-ontological ethics [18].

Yet, behind the allegedly objective, unbiased and disinterested reasoning about justice and fairness, there almost always lurks something that has nothing to do with ethics. For example, if we have the power to hurt someone who humiliated us previously at a time when we were powerless, we will probably do it, but call it 'justice' rather than 'vengeance'. If we see a very big and expensive car parked in front of a village restaurant, we might complain about unfair material inequality and call for redistributional measures. But our underlying feeling is probably closer to personal envy than a genuine desire for fairness. We are however afraid of admitting such motives since our consciousness has evolved to deny the influence of base unconscious feelings on our conscious thinking. Moral fear rather than reason is therefore revealed through our moral systems. This fear is however masked by the taboos and hierarchies of society [13].

2.2 Learning to live in two worlds: the laws of cultural evolution

There are natural forces in the human being that are nevertheless conducive to amity and tolerance as opposed to the forces conducive to belligerence and intolerance. Such forces may indeed reflect a moral truth that is consistent with human nature. The notion of moral truth is however more a product of cultural evolution than natural evolution [19]. For example, the ability to argue persuasively that your rival had no valid grounds for grievance would have been favoured by natural selection in the age of hunters and gatherers when outsiders mainly represented rivals who competed for the same resources. Yet, once the human being started to engage in trade and technological innovation and thus jump-started cultural evolution, zero-sum games transformed into non-zero sum games in which it suddenly made sense to engage with former rivals and exchange goods and services for the benefit of both parties. This transformation also required a change in the evaluation of the moral status of the former rival and the ability to look at things from his or her point of view. It would be a first step towards overcoming the dualist mode of thinking and discovering the benefits of collaboration with people who do not belong to the same community. In other words, it was the beginning of a new mode of living where people had to learn to live in two worlds: the world of their own community in which the informal rules are based on fairness and reciprocity, and the world of society at large in which formal rules were designed to make the pursuit of self-interest mutually beneficial [20] [21] [22]. As a consequence, non-zero games with people outside the familiar community be-

came not only beneficial for the individuals, but also enriched their respective communities. However, the costs for communities who do not want to or cannot participate in such exchange also increased continuously and help explain most of the global inequality we face today. Thus, in order to create equality and fairness more exchange and not less is required. This makes it essential that our education system starts to teach students how to learn to live in two worlds that function according to different rules, but need each other to ensure long-term survival. The community we grow up in teaches us norms and values that are based on fairness and reciprocity and gives us a cultural identity and the ability to trust the people in our neighborhood. They ensure that traditions that provide meaning and orientation to members of the community are preserved and passed down to the next generation. In turn, members who undermine the dependable unwritten rules of interaction within the community can be quickly identified and punished. These informal rules of the community, which can be relatively easily enforced and are based on fairness and reciprocity, stand in strong contrast to the formal rules of large markets and democracies, which are based on the assumption that individuals pursue their self-interest once they seek employment and a career outside their community. In this world of society at large, one cannot assume that the informal rules of one's own community still apply. Instead, successful formal rules in business and politics are designed in such a way as to make daily interactions outside the community beneficial for the parties involved, even though they might not share the same values. In other words, successful formal rules tend to produce unintended positive externalities by ensuring peaceful interaction between communities that pursue primarily their self-interest. Once members of a community are successfully integrated into the global economy and learn how to defend their interests in the political arena, they can also take better care of the more vulnerable members of their community and preserve their cultural identity by spending the revenues gained from exchange on community activities. At the same time, they adjust their traditions to a changing world so that they remain attractive and viable for the next generations. In such a social environment the strongly entrenched dualism in communities of 'we versus them' can be overcome because people recognize that exchange is a non-sum zero game that does not threaten their identity but enriches it.

2.3. The expansion of non-zero sum games

The first great expansion of non-zero sum games happened around 1000 BC when the Phoenician cities in the Levant started to establish a network of trading points along the shores of the Mediterranean. Phoenician merchants formed cosmopolitan trading companies where Jews, Greeks and other ethnicities shared one ship for a period of about four months to sell their goods in other parts of the world and bring foreign goods back to their home country. The main objective of the Phoenician merchant may have been to convert his service into a profit by exploiting the price differences between centre and periphery in the new trading space. However, the moral by-product of this undertaking was better access to knowledge, goods and services for people who previously suffered from physical shortages, a lack of opportunities and few possibilities to change their situation. In addition, people from one culture learned about the habits, institutions and languages of people from another culture, and the joint pursuit of a business forced them to respect the other point of view and seek compromise rather than confrontation [22, 23].

The resulting extension of moral imagination from friends to rivals is therefore improving the ability of participants to play games with other parties more successfully and thus realizing the gains from non-zero-sum games. It then suddenly makes sense to see people not primarily as potential enemies but as people one can do business with (21).

2.4. Reforming the social order based on trial and error

Even negative-sum prospects that may result in side-effects of the proliferation of non-zero games such as increasing social inequality, depletion of natural resources, climate change, and environmental degradation give entrepreneurial innovators an incentive to make better use of available knowledge to come up with new technologies, services and policy instruments that help address these challenges through technological and intellectual renewal. Global problems therefore cannot be solved by simply physically destroying the existing social order and replacing it by a new one that, over time, will look increasingly similar to the old one. Instead they must be addressed by reforming it. Past evidence indicates that successful reforms always reflect a process of adjustment to changing circumstances. They are achieved not just by means of regulating unsustainable change but also by facilitating sustainable change through the mobilization of science, technology and innovation for development [22]. Yet, the mobilization of science must not take place at the expense of human empowerment, ethics and religion, as will be illustrated in the following section on Renaissance Florence.

3. The virtues of Renaissance Florence

The message inherent in all the great religions is to find personal salvation by recognizing the human nature that we all share and obey to the necessity of life [1]. This necessity comprises the obligation to fulfil one's own potential in order to become productive in life and to contribute to the flourishing of the society on which our well-being depends [24]. The moment in history when the search for personal salvation and fulfillment coincided most closely with social salvation was during the Renaissance in Italy in general and Florence in particular in the 14th and 15th century. Even though this was an age of political, economic and cultural turbulence, it opened a unique window of opportunity for the underprivileged to improve their livelihoods through the development of unique skills and hard work. The reason why both human creativity and social welfare thrived best in Florence was probably because the privileged classes found it more difficult to maintain their superior social position by means of mere oppression of the lower classes. As Goldthwaite [25] reveals in his book on 'The Economy of Renaissance Florence', this was largely related to the political and economic crises that hit Florence in the 1340s. At that time, the ruling classes, consisting largely of established bankers, traders and wool producers, were confronted with serious economic problems such as bankruptcy, sharp devaluation of their currency, the 'Florin', due to a steep fall in the ratio of gold to silver, and rebellion of the local wool workers (the Ciompi revolt). At the same time they faced political troubles such as the war against Lucca from 1336–1338, the tyranny of the Duke of Athens (1342–1343), and the victory of the popular government over the oligarchy (in 1343). In addition to these social turmoils, a shortage of consumer demand and labour supply in the economy, as a result of a severe famine in 1347 followed by the Black Death, made things even worse.

3.1 Crisis and renewal

This period essentially weakened the power of the ruling guilds in their capacity to exclude new innovative players from entering their business. It also led to new economic and political institutions that favoured empowerment through entrepreneurship across all social strata.

These institutions were not designed by a well-meaning social planner, as neoclassical welfare economics assumes, but were a by-product of the struggle of the underprivileged for more political and economic participation in the city. Yet, the parties involved did not see the struggle as a zero-sum game, where one party wins and the other loses, but favoured formally established political and economic platforms of negotiations where compromises could be reached in mutual respect. The poor did not primarily insist on the redistribution of wealth and power but rather the creation of economic opportunities that would allow them to improve their economic situation gradually, enable them to invest more in the health and education of their offspring and to ensure that they would have more possibilities to fulfil their potential. This pressure resulted in the establishment of countless elementary and abacus schools where the youth learned how to read, write and calculate. Moreover, everyone learned the basic principles of accounting.

3.2. The poor are more than blessed objects of charity

After the uprising of the wool workers, known as the Ciompi revolt in 1347, the poor were regarded with increased suspicion by the ruling elite. This partly explains why charitable institutions such as the Ospedales and Confraternities, which were largely funded by the guilds to give charitable support to the less privileged members, went into decline in the second half of the 14th century. It is therefore all the more surprising that the period that followed the upheaval is characterized by relative social and political stability compared to other regions in Europe. Obviously treating the poor with some suspicion, rather than as blessed objects of charity, also implies taking them more seriously as players who collaborate and compete with the rich in many public institutions. If the privileged treated the underprivileged with suspicion they were probably also more likely to keep the level of discontent among them as low as possible by integrating them better into the economy. This integration was possible because even the poor were now literate and able to do basic accounting. It became more attractive for companies and artisan workshops to hire poor yet educated young people. The master–apprentice relationship gave them additional valuable on-the-job training. Such training involved not just basic business practices and techniques in a particular field but also joint trips to nearby cities or even work in a branch in a foreign country. This made the trainees more familiar with other cultures and languages which enabled them to learn and understand different points of view. Even though they could not count on formal employment contracts they were still partially protected from abuse by the guilds and the formal political institutions in Florence. Moreover, the fact that they had to work for several different masters in several different fields gave them more versatile professional skills and a greater sense of autonomy. The most important aspect of this education was, however, that they were always in personal contact with the rich of Florence. These wealthy people did not despise entrepreneurial spirit and were very much concerned in their economic and political activities to foster a

spirit of merit-based pride and self-confidence among all the citizens of Florence.

3.3. The tools of empowerment

The tool of empowerment that created social mobility and an unseen productivity and creativity among its citizens was therefore a social network that was supportive of the young and skilled people who wanted to set up their own business. Moreover, there were economic institutions in place that allowed these skilled people to gain access to credit, investment and well-trained employees.

One of the important economic institutions that made entrepreneurship attractive was the concept of partnership. Partnerships (*compagni*) were a fully evolved institution at the end of the 14th century. Men joining together as *compagni* (e.g. merchant bankers, artist-investors) drew up articles of association according to which they agreed to contribute capital towards a business venture usually lasting from three to five years. The articles of association would specify each partner's contribution to the capital and how his share of profits was to be determined among other things.

3.4 Public–private partnerships to facilitate social and economic development

These small companies had no need for fixed capital, neither property nor equipment. The head office of the firm was presumably located in the residence of the principal investor, and branch offices and warehouses were rented. Partners could commit further capital on specific terms (e.g. time deposits from outsiders).

The fixed capital necessary to introduce a new product or technique to the market required major investors, however. The Medici regarded the holding company as an appropriate tool for that purpose in the 15th century. By using one partnership to invest in another, the original investors clearly increased the capital they controlled, but they hardly exploited this possibility. As the leading international merchants, the Medicis were also investing in foreign companies that seemed to be highly innovative in the production of high-value goods. Subsequently, they invited the most skilled workers of these companies to set up shop in Florence and train local people; the import of know how in tapestry art and production from the Low Countries illustrates the case well. In addition, the Medicis established and funded artistic workshops under their supervision, creating a state enterprise for the production of objects of great luxury and prestige. Many of the invited local and foreign artisans and artists were put to work in the Palazzo Vecchio, the official residence of Cosimo di Medici I; later also in the Uffizi as well as the Palazzo Piti and its gardens. The state enterprise they established included the production of goods that required precision work and demanded familiarity with the latest insights in science and technology. The goods produced included clocks, quadrants, compasses, armillary spheres, terrestrial globes, astronomical and geographical maps, glass instruments and lenses.

Since the Medici were always either de-jure or de-facto the political power in Florence throughout most of the 15th century, one could talk of an entrepreneurial government that emphasized the importance of public–private partnerships and private initiatives to enable people to make optimal use of their skills and thus lift themselves and their families out of poverty.

This investment in human capital, the promotion of entrepreneurship and the relative political stability helped prepare Florence for the regionalization of the western Mediterranean economy thanks to the transport revolution (improvement in sailing and navigational techniques) that emerged in the second half of the 14th century. Even though Florence could not become a maritime power itself, it managed to take full advantage of the new opportunities in trade because its people had unique skills and sold products that were highly in demand.

At the same time, Florence was less prone to being strongly affected by external economic shocks, due to the robust middle class that emerged owing to the institutional reforms. This middle class had a decent amount of savings (as documented in the increase of bank deposits at that time) and, whenever the exported-oriented markets in Florence lost an important regional market to rivals, the shock could always be absorbed by resorting to the home market and selling more goods in the region.

3.5 Dealing with the church

There is no doubt that poverty, social inequality and criminal violence were nevertheless widespread in the city of medieval Florence. Such phenomena always appear once people gain more political and economic rights because many tend to abuse them. Moreover, the city was almost permanently at war with other Italian states and other European powers. Yet, all these wars mostly occurred outside the city walls and apparently did not affect the economy within the city in any lastingly negative way, judging from all the major public works that were funded and accomplished in the 15th century [26].

The business spirit of Florence had, however, a potential opponent in the Church, which warned about the divine punishment awaiting people who dedicate their lives to making profits. Avarice and usury were regarded as major evils and in Dante's Divine Comedy and a particularly

painful punishment was designed for those who indulged in it. Yet, the churchmen in Florence were also well aware of the importance of wealth generation for the city to flourish as well as for the support of their social institutions. Moreover, they were also aware that it was more difficult to impose religious oppression on well-travelled people with cosmopolitan values [26]. For the rich who were still concerned about the afterlife, the church went a long way towards allaying their anxiety via confession and the institution of purgatory. The Church put instruments at the entrepreneur's disposal, such as commemorative masses, private chapels, donations to welfare and religious institutions and the patronage of religious art. In terms of usury, an accommodation of theology to practice was made. Florentines, at whatever cost to their conscience, found handy ways to circumvent these restrictions – or made gestures of atonement in their final testaments. Churchmen in return tried to adjust doctrine to reality. They were even paying low interest rates for loans to build Monte di Pieta, a religious institution designed to aid less fortunate people by providing an alternative to the Jewish money lending system [25].

3.6 Supportive humanist ethics

Humanists who had close relations with the entrepreneurial class in Florence further pointed out the positive aspects of entrepreneurship for society. They used the classical concept of magnificence to explain that wealth is good for the individual because it liberates him from constraints and, in turn, allows him to liberate others from their constraints. Moreover, it was argued, it helps one to become virtuous and to participate in civic life [26] [27].

Interestingly, humanists were much less concerned with the generation of wealth than with the question of how to spend it wisely [25].

3.7 Good governance facilitated by the people of Florence

In Renaissance Florence, the underprivileged seem to just have followed the evident principles of political economy using their informal networks to lobby for rules that were more conducive to entrepreneurship and empowerment. In turn, the privileged were not just rent-seekers living off the taxes and land rent, as was usual in the period of feudalism, but were engaged in international commerce and business development. In other words, the political and economic institutions were largely a bottom-up process designed by people who did not regard politics as a non-zero game. These institutions allowed for long-term business planning by increasing predictability and reducing uncertainty.

No one had the pretension at that time to know how economic development itself should be designed by means of a wise social planner (as neoclassical welfare economics still does). The adoption of top-down planning emerged only with the rise of economic theory in the 19th century and reached its climax with the use of linear programming and general equilibrium models to predict future economic development. Many of its models were first developed in communist countries but were then adopted in neoclassical welfare economics. All are based on a purely rational and materialist view of the human being. While it was naïvely assumed in communism that this individualism would be moderated by the common long-term goal of a utopian society characterized by ubiquitous social equality, modern economic theory started from the equally naïve assumption that every individual grows up in a social vacuum and is endowed with a sort of innate knowledge or rationality about how to pursue his or her material self-interest.

In the capitalist society of Florence, the term "individualism" would not have been comprehended [25]. No one could imagine himself to be someone outside his family, his guild or his social network. There was still a full awareness in the commune that things can only be achieved together. It was this corporatist spirit that made Florence competitive and humanist alike. This great period in human history allowed people to explore the world and take advantage of its opportunities because they had a solid base of social support. It also enabled them to become risk-takers and innovators. Their achievements not only benefited them as individuals but also their commune and, ultimately, all the subsequent generations worldwide because their activities are found in the great archives they left behind documenting all the disciplined and formal activities of this time.

Conclusion

The current economic downturn will have an impact on future academic research and training, especially in the fields of ethics and economics. These two academic disciplines have up to now enjoyed great prestige in the social sciences and public policy due to the general belief that they could provide reasonable guidance in a fast changing and increasingly interdependent and uncertain world. Yet, both disciplines are still largely based on an abstract, mechanistic and ideal view of the human being, either as the purely selfish and rational homo oeconomicus or the purely reason-guided Kantian ideal that follows rational and abstract moral laws in daily life. Not only the current financial crisis but also field research and laboratory experiments in cognitive psychology and experimental economics have rebutted such claims of an ideal human being. Instead the real nature of the human being as an active searcher for patterns in life that provide orientation and meaning and guidance in a constant adaptive process of trial and error has been re-

discovered. It is now increasingly recognized that public policy should focus on the real nature of the human beings rather than any form of abstract ideal. The human being must always be embedded in a community that provides essential material and mental support, spiritual meaning, social trust and a sanctuary to test out the adaptive rules that help guide a successful life. At the same time, everyone has to realize his or her potential and make a living by learning to compete and cooperate with people beyond his or her community. The success outside the community can then feed back into the community by enriching it by means material support and the introduction of new knowledge. All these insights hint at the fact that capitalism thrives best in a world where individuals are strongly embedded in community activities.

Inspired by the ideas of Rousseau and Freud, a cult of individualism – unrelated to the system of capitalism as such – has led many people to feel that they need to separate themselves from their original community (including parents and siblings) in order to find their true selves [28]. Yet, since the belief in the true self is again grounded in a sterile idealist view of human nature it has not led to liberation but merely resulted in like-minded and rather boring 'Ersatz'-families [29].

Unfortunately, many of these searchers for their true selves pursue high-minded ideals in life and often end up working in teaching and development cooperation where they tend to spread these false beliefs and inadvertently produce a culture of victimhood rather than entrepreneurial initiative.

Africa's education system is in urgent need of a radical reform. Such reforms will allow it to drop outdated theories in ethics and economics in school and university curricula and instead directly focus on the new empirically well-established insights about the real nature of the human being. This article highlighted that these insights are not new but constituted an essential pillar of humanist education in Renaissance Italy many centuries ago.

Education and public policy in Renaissance Florence could provide a template for a project to reform education and vocational training in Africa.

Even though macroeconomic theories and ethics outside theology did not exist in Renaissance Florence, economic and social policies were firmly grounded in the anthropological observation that human action is and has always been guided by emotion as much as reason. The social and economic institutions at that time were not planned from above but grew from below. As a consequence, public policy was based on the proper understanding of real human nature rather than derived from an abstract ideal.

As in Renaissance Florence, every child in Africa should leave elementary school with basic writing, reading and calculating skills. Subsequently they should be trained in modern secondary schools that provide solid knowledge in IT/ICT, accounting and the basic rules of running a business in the formal sector. This education would be linked to formal apprenticeship training in the local private sector, if necessary subsidized by the public sector. Access to university should be based on an overall entrance exam together with a certificate of experience from the local private sector, which would prove that applicants are not just good at theory, but also know how to apply knowledge in business practice. After all, the goal of education cannot be merely to educate bureaucrats but also entrepreneurs who generate private and social wealth and thus contribute to the emergence of an empowered middle class. The experience not only of Renaissance Florence in the 15th century but also many successful emerging economies today has shown that an empowered middle class is ultimately a condition for a functioning democracy, the respect of essential human rights and governments that start to invest in their own people.

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Science Education in the News

Science tools in the Classroom

By Peter Horszowski

Would it change your attitude to practicals and field work if you could measure anything you liked? Force, motion, pH, pressure, carbon dioxide, light, heart rate - just about anything, really. A new system from PASCO Scientific allows you to do that. And not just measure, but store, record and analyse the info on your computer as well.

SPARK Science Learning System is an all-in-one mobile device that seamlessly integrates the power of probeware with inquiry-based content and assessment.

Source: www.pasco.com

It consists of a choice of sensors, software and a USB link. There are about 50 sensors currently available and more under development. A user would simply plug the link into a USB port on computer, and attach a sensor or a combination of sensors. The software automatically recognises both device and sensor, while the computer provides the power.

On screen start/stop controls and a number of different data displays such as meters, digits, tables, scopes and graphs provide easy control and access to information. USB being a very fast communication technology means that the device will not only measure multiple quantities simultaneously, but it does it extremely quickly, over 20 000 times a second, if necessary. The need for such high speed is obvious for experiments on motion where velocity and force change significantly during each millisecond. But sometimes it is the slow sampling which is the most handy. Taking data every half hour or so, for instance, would be more appropriate for a 24 hour examination of pH change in a fish pond.

There are a number of advantages to this computer based system:

- It is cost effective. Because the link and software is the same for all sensors, simply add a new sensor for a range of new experiments. If the initial system was used to monitor motion and force, for example, a very small investment later for a temperature sensor, would open up a range of thermal investigations in physics, chemistry, biology and geography.

- More time with data and less with measurement. Because it is quick and easy to get accurate data, less time is spent on measuring and more time analysing.

- It is flexible, so you can easily change parameters, for scientific investigation. In collision experiments it is simple to alter the mass, change the pulse, track angle, for example. And then again it is easy to get data if you wonder "what happens if"...

- It opens doors. Some experiments can't be done without technology such as this. If for example you drop a magnet through a coil attached to a voltmeter, all that is seen is a flick of a needle. But if the coil were a attached to a voltage sensor the emf spike could be recorded exactly. And it could be analysed: on a time graph, zoomed up to a very fine time scale, and then integrated under the curve for exact quantitative results. In theory it would be possible to do the slow sampling experiments without this technology, but who wants to wake up at 3 am to take a humidity measurement in the terrarium?

In Southern Africa, this technology could have specific advantages.

It stimulates enthusiasm for science. With the sensors, students feel like real scientists - not just going through those old clunky motions, hoping that results match the worksheet. Also a bit of competitiveness and spirit can be introduced. Adele Botha, from Cornwall Hill School in Irene, challenges her students to use their own motion with an ultrasonic mo-

tion sensor to match pre-arranged velocity and displacement graphs. The software scores performance which generates healthy competition between groups and classes. Another spur to enthusiasm is the Xplorer, which works not just as a USB sensor link but a datalogger with display. Students can use it for outdoor work and ad hoc investigation. The American International School of Johannesburg, for example, used an Xplorer for temperature levels in the Northern Province during the 2002 eclipse.

It encourages female enrollment in science. Case studies have demonstrated this effect. John Layman from the University of Marlyland, suggested that it was because of a leveling effect. These days, girls and boys are equally familiar with computers and computer accessories but the traditional practical equipment, like stop watches, calipers and multimeters were thought of as 'boys stuff' .

But for this system to work in the southern African setting, access to computers, computer literacy issues and overburdened teachers need to be addressed.

Fortunately, some of these difficulties can be overcome by creative teaching. Some South African schools for example, use projectors, large monitors and TV adapters to use the probeware as part of a teaching demonstration, instead of a separate practical. Because it is quick to set up and very visual, a lot can be achieved in a lesson that incorporates a computer based demonstration. Homework can be useful too. Students save the results to disk and analyse them later, wherever they have access to a computer.

The shift towards outcomes based education also gives some assistance. The Pasco system's flexibility lets the learner approach a variety of objectives from different angles via a number of interrelated sciences. And the centering of the learner gives scope for individual tangential investigation without overburdening the facilitator.

Documentation is available for several hundred experiments and new experiments are posted on the internet regularly. For examples of these see www.pasco.com/experiments. Worksheets allow participants to become familiar not only with the utilities but also the possibilities, so that they can get creative with new types of experiments. Dawn McMaster of the American school has been using the probeware for a few years now. She says that she enjoys customising her own experiments and that, given the choice, the students prefer the Pasco sensors for experimental work.

There is no single solution to the problems facing science educators in Southern Africa but this kind of technology could help.

For information on the latest USB PASCO Probeware for Science Learning, please contact Peter Horszowski at (011)882-1435 or peter@pert.co.za

Source: Adapted from www.scienceinafrica.co.za

The online resources for educators and students includes manuals and experiments in the core science fields: biology, chemistry, environmental and earth science and physics.