Towards A Better Quality Education In Engineering and Technology In Developing Countries

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In theory, it is by now very much clear and widely accepted that science and technology are necessary for progress and welfare. But, it is essential to point out here that in fact they have no real impact unless if they are applied to development at points of production. It therefore follows that allocated financial and human resources should be used and managed in a way as to maximise such an impact. Any action against this will result in wasting and costs.
In practice, and as far as developing countries are concerned, overall and technological performances are unfortunately not generally good. For, despite ambitious programmes and important investments made in the fields of technology transfer and education, only a few of those countries have succeeded in reducing the so called 'technological gap' and realised technological take-off.
How could one, then, explain this situation? This is exactly what this joint paper is concerned with. Based on some available data and practical observations of their country (Algeria), its authors attempt to add another explanation to what is actually provided in the literature about the issue. For them, the real problem has to do mainly with the way or manner with which the issue has been treated and managed. In brief, particular lack of flexibility and interactive facilities affect necessarily institutions' good functioning and overall performance.

I- Introduction

At the beginning of the 70s, the United Nations[1] has urged all developing countries to raise the proportion of their gross domestic product, which is devoted to science and technology (S & T), in general and to research and development (R & D) in particular. Technology education was, obviously, part of the issue. And, it has been implicitly argued that without practical knowledge and technical tools, growth and progress would be minimised or very slow.

Since that U.N. urgent appeal, the majority of developing countries have been paying more attention to education, technology and research. In doing so, however, policy makers have generally been trapped between two troublesome choices: that of providing broad access to education or developing high quality schools. If this is, in

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[1]: United Nations (1971). See also UNESCO (1988).

fact, a bad way of looking at things[2] as far as general education is concerned, we argue that it is also the same for engineering and technology education at all levels. The usually adopted approach consisting of providing more inputs rather than better ones, in order to overcome the problem, could not be not be right either.

At the outset of our analysis, it is primordial to recall that countries are different in their overall development, capabilities and needs. Although there are common characteristics, but needless to emphasise that there cannot be a unique theoretical model to apply to all of them. That is to say that a case by case study would allow a deeper analysis, more insights and appropriate solutions.

II- An alternative explanation of the problem.

The particular argument of this paper is that developing countries' general bad performance, in the field of engineering and technology education, could be explained mainly by the dysfunctioning of the relevant system. From a systemic point of view, any institutional setting should normally have its different and various elements linked between each other in an effective network. Otherwise, drawbacks would appear and affect the global efficiency. When applying such an approach to engineering and technology education, it could be plausible to make the following assertion: That as a system, such an education cannot be performing when problems or difficulties affect one or more of its composing elements.

Henceforth, the usually much stressed argument of funds scarcity cannot really and totally explain the quality education fundamental dilemma in which most developing countries live in. If one considers, for example, education and training budgets' evolution of Algeria, it will appear that the proportion is important and clearly greater and greater over the years[3]. As for the percentage number of technology students, recent available data[4] about the same country indicate that it is just over 16% of the total number of students attending the secondary education level. Also, that the number of relevant establishments is 215, which is equivalent to 22.2% of the total number of secondary establishments[5].

In the higher education sector, scientific specialities are largely dominant all over the country's universities and higher education institutions[6]. The teaching language is again dominantly French, though there are some institutions, which teach mainly in English[7]. As far as Arabic is concerned, it is practically marginal in those institutions[8]. The proportion of students in technology education, strictly defined, represents 27.30% in 1991/92; 26.50% in 1992/93; Only 7.50% in 1994; And 7.40% in 1995[9]. This drastic decline could be explained by new students'' tendency towards

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2: Hanushek (1995), p. 227.

3: See appendices at the end of this paper, table 01.

4: CSE (1997). See appendix table n° 02, for compiled information.

5: There exist two types of secondary schools: ''colleges et lycés''.

6: In Algeria, there are over 17 higher education institutions, among them traditional universities, higher schools, university centres, and recently new born : 'Grandes Ecoles''

7: It Is worth noting that this concerns technological training (Electronics).

8: This an important point to be mentioned; For, it is usually argued that education and training low level or quality is due to the use of Arabic. While the truth is that, as mentioned, French is largely used.

9: See appendix, table n° 3.

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other specialities as thy are open. This is particularly true as the Algerian economy liberalises and calls for graduates in disciplines such as accountancy, marketing, management and so on.

Nonetheless, the most remarkable contrast of all concerns spending; Some disclosed information, which are not usually published, reveal that yearly budgets, in so many Algerian public institutions including schools, research centres and so on, are rarely consumed at full length. As a matter of fact, there is now a widely practice which is that directors rush to purchase a maximum possible of almost anything consumable every time a year is coming to its end. Paradoxically, this usually occurs despite that important needs may not have been satisfied. In our view, such contradictions find their explanations in the inflexibility of the budgeting system itself. Many other bureaucratic practices can be found, such as the impossibility of covering some urgent expenses when they are not clearly defined or previously registered in budgets.

III- Factors allowing for better prospects

Future improvements of prospects, in the field of engineering and technology education as well as research in developing countries, should take account of the following essential points:

III.1- *Improvements of standards.*

Standards, used either at entrance or graduation, are generally caduceus or applied but very smoothly. Absence of standards does, obviously, leave plenty of room for mediocrity and, thus, incompetence. The main lacuna concerning standards, which are applied in many developing countries, could be described as follows: On the one hand, standards are not equally generalised on a national level, that is to say that one could find technology education establishments applying quite high standards while others in the same area or elsewhere applying poor or less rigorous ones. On the other hand, that even in cases where considered high standards are applied, these are not up graded or improved as to match with international ones. Notwithstanding, all acquired knowledge need to be up dated. In general, it is argued that such a requirement should be satisfied every four or five hears on average. Henceforth, standards should also be up graded at some time intervals.

III.2- *Setting up interactions and interface.*

Research works[10] carried out on the relationship between S & T on the one hand, and growth or development on the other, argue very plausibly that without linkages the impact of S & T would be very limited if not null. By the same token, it could be possible to argue too that without effective interactions and interface between technology education and industry, performance would be very low. By interface, we mean all working and efficient facilities and services, which link between various parties of the education and S & T system. The existence of such an interface should provide enough incentives for people to carry out real activities and, thus, reduce their time wasted in trying to solve extra problems or marginal difficulties. In practice, such things are usually solved in developing countries through reliance on informal relationships and canals. Some times, this kind of linkages replaces even the formal ones.

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[10]*: See particularly Silveira (1985).*

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III.3- *<u>Making good use of Information and Communication Technologies.</u>*

The observed contrast on this question is that while almost all types of information technologies (computers and telecommunication tools and networks) exist in many developing countries, yet things do not work ‘’normally’’ let alone as rapidly and efficiently as it should be[11]. It is not, for instance, unusual to find a number of personal computers and other very advanced electronic instruments in various organisations without being used. They may also be broken down juste after a short time from their purchase. The ‘‘Internet’’ has also been introduced in those countries, yet ‘’intranet’’ are not set up or used adequately and efficiently. What is, then, the utility of a S & T policy which does not provide necessary means and facilities for purposes of efficiency and effectiveness? How could it be possible to be efficient when communication networks (telephone lines) are badly working or interrupted for long periods of time? Should videoconferences, for example, be exclusively limited only to some people, institutions or areas on a non scientific basis?. The matter is, indeed, one of true responsibility over the scientific community and thus of conscious decision making.

III.4- *<u>Recycling and continued education or training</u>*

Obvious reasons for such actions are the need for acquiring new or up dated knowledge and obtaining higher degrees and thus new qualifications. Whether engineers and technologists have been trained and graduated locally or abroad, their capabilities could rapidly be by-passed by new theories, models, methods, visions, approaches and information. In the particular field of production of scientific and technical information, the speed is so quick that obsolescence is most surprising. Hence, quality of research and education depends not only on more and more knowledge but also on new ones. When it is not possible to follow normal education cycles in colleges and universities, recycling and shortened training could provide with more abilities and capabilities.

III.5- *<u>Training through research</u>*

Nowadays, the relationship, between teaching and research, does not need to be proved. As the latter implies search and production of extra or new information and knowledge, participation in research projects could consequently allow involved individuals as well as teams to be promoted and upgrade the quality of their transmitted knowledge. Once, research activities are carried out under the supervision of competent individuals and on the basis of good standards, up dated and correct knowledge as well as improved education methods could be obtained.

III.6- *<u>Rethinking polyvalence Vs specialisation</u>*

One of the most delicate and debatable aspects of technology education is whether it is preferable to go for specialised relevant institutions or allow for a polyvalent training. Should this question arise at a macro-economic level, it is quite reasonable and acceptable for each country to dispose of both specialised and polyvalent technology education structures. Obviously, as countries differ in their capabilities and needs, priority for one of them over the other may not have always to be given. In other words, depending on real needs for higher technological levels and

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[11]: Imagine, for instance, that to send a message using the fax in some public institutions could take days instead of normal few seconds. This does often occur because of lack of adaptation of relevant requirements (power for example) and people’s behaviour. It is not unusual either to notice much laziness and lack of consciousness along many people at work. This is perhaps the problem of culture.

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capabilities, a country may have to have both types of technology institutions. That is a more complete education system as part of the S & T national policy.

III.7- Starving for technological ''jumps''

Experience of the Newly Industrialising Countries (NICs) clearly shows that, citerus parabus, it is quite possible for countries to make technological ''jumps'' in some particular technological fields. This is, for instance, the case of electronics industries. Evidently, one finds in many countries, including the developing ones, technical capabilities not only in production of computers and auxiliary activities, but also in relevant innovative ones[12]. The point here is that important technological progress is possible even in developing countries, as long as research is carried out or encouraged and investments are made.

III.8- Being or remaining technologically awake[13]

As an activity largely practised in the developed countries, it cannot and should not, in any way, be exclusive to them. Nor could it be considered useless for the developing countries. Described as a systematic observation and analysis of the environment, in order to select interesting or useful scientific and technological information to be made available for decision making[14], it is a first class way which helps getting access to up dated knowledge and information in a very short if not on time. Using the available information technologies, access to world diffused information is within seconds and at a very low price[15].

III.9- "Thinking global and acting local"

The actual tendency towards globalisation of markets and technologies calls for all countries to integrate the world economy. What this implies is that in the future, there would be much less chance for nations, their institutions and enterprises which do not or cannot follow up in the rapidly changing environment.

Isolation and search for complete independence of any type have no more sense. Instead, integration and inter-dependence become important strategies for overcoming all sort of shortcomings and weaknesses, be they industrial, technological or any others. As geographical frontiers can be put down, like in the actual new Europe, provision of qualitative manpower becomes a similar requirement everywhere on that continent. Either for specialised industrial jobs or applied research, high quality engineering and technology education is always *sine qua non* for recruitment and success.

IV- Conclusion.

If economic growth and overall development are linked to technology, this latter is in its turn linked to scientific and technological knowledge. Evidently, the transfer of this does not take place but mainly through education, training and research.

12: It is implicit particularly in research works carried Dehlman and al that once a country reaches the phase of innovation; it means that it has made clear and important steps in technological development. See Dahlman et al, (1985).

13: ''Veille Technologique" as part of what is called Business intelligence.

14: Jakobiack (1991).

15: It is sometimes argued that such price is absolutely zero, but this is not quite true since for individuals there is always subscription fees, which could be very high add to that fees of consumed telecommunications.

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Therefore, the better and higher their quality is, the more positive would be their impact on living standards, well being and prospects.

Developing countries are not all similar in everything. Those which are making quick progress will need higher and higher qualified manpower, greater technical capabilities and innovativness. Notwithstanding, this latter, in particular, can be achieved only on the basis of a high quality engineering and technology education.

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Appendices:

Table n° 1-

AN EXAMPLE OF EDUCATION AND TRAINING YEARLY BUDGETS
ALGERIA: 1992 - 2000

Million Dinars

	1992	1993	1994	2000
Amount:	9.502,9	14.380,7	16.649,2	
Percentage:	13.48	14.48	14.72	

Source:
ONS (1996), p. 380. Computed by us.

Table n° 2-

TECHNICAL SECONDARY EDUCATION
ALGERIA: 1994-1995.

Speciality	Number	% Male	% Female
Electrical engineering 12726	70.75	29.25	n.a
Mechanical engineering 10486	84.89	15.11	n.a
Civil engineering	9189	71.74	28.26
Electronics	4052	77.60	22.40
Electro-technics	7646	76.52	23.48
Mechanical construction	9686	89.99	10.01
Const. & Public works	7439	81.43	18.57
Chemistry	25491	59.26	40.74
Eco. an management:	40415	49.92	50.08
Accountancy	9325	63.91	36.09
Sub-total	136455	65.59	34.41

Source:
CSE, September (1997). Our compilation.

Table n° 3-

EVOLUTION OF TECHNOLOGY HIGHER EDUCATION STUDENTS
ALGERIA / 1991 - 1995.

	91-92	92-93	93/94	94/95
Number:	21287	23540	17870	17647
Total (*):	77962	88833	238092	238427
Percentage:	27.30	26.50	7.50	7.40

Source:
ONS (1996), pp. 92-93

(*) : Of all specialities including: Medicine, Maths, Applied Science, Natural Science, Veterinary Medicine, Archaeology, Economics and Commerce, Political Science and Information, Social and Islamic Sciences, Literature and Languages.

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ملخص

نظريا إنه جـد معـروف و واضـح الآن أن العلـم و التكنولوجيـة همـا ضـروريان للتقدم و الرفاهية. غير أنه من اللازم الاشارة هنا إلى عـدم فعاليتهمـا إلا إذا طبقـا فـي مواقـع الإنتاج. و على هذا الأساس، يفترض أن توجـه و تـسير المـوارد الماليـة و البـشرية بطريقـة بحيث تعظم أثرهما.

من جهة أخرى و عمليا، فإن الأداء العـام و التونولـوجي بالبلـدان الناميـة لـيس جيـدا علـى العموم. هذا بإعتبار أنه رغم البـرامج الجـد طموحـة و الاسـتثمارات الهامـة المـسخرة فـي مجال العلم و التمنولوجية، إلا أن عددا قليلا فقط مـن تلـك البلـدان اسـتطاعت أن تـضيق مـن الفجوة التكنلوولجية مع العالم المتقدم.

كيف يمكن تفسير مثل هذه الوضعية؟ هذا بالظبط مـا يهـدف إليـه هـذا صـاحبا هـذا المقـال المشترك. فعلى أساس المعطيات المتزفرة و كذلك الملاحظـات الميدانيـة، يبـادر المؤلفـان إلـى إضافة شرح آخر إلى ما هو متـوفر فـي الادبيـات حـول الموضـوع. بالنـسبة إليهمـا، فـإن المشكل الحقيقي يرتبط بالطريقة أو الاسلوب الذي يعالج المـسألة. و بـصفة خاصـة، فـإن عـدم المرونة و غياب الـدعائم المتداخلـة همـا العناصـر الأساسـية التـي تـؤثر سـلبا علـى أداء المؤسسات المعنية و كذلك الأداء العام.