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Innovation Training in Algerian Engineering Schools: Aiming to Serve Companies

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Abstract:

This article questions the way in which engineering schools in Algeria (North Africa) approach the prescriptions to train for innovation, which are widespread in Europe and beyond. After having presented the characteristics of engineer training in relation to the training models that can be found in Europe, the authors examine the different concepts of innovation and the objectives expressed by the teachers as to their desired end results. As a complement to articles published in the EJEE which explore pedagogical practices in innovation training, this article examines the injunction to train for innovation and the approaches of different stakeholders. This work enables the comprehension of how external prescriptions, especially from Europe, have permeated engineer training in North Africa. It contributes to the analysis of the dynamics at play on the international scene in terms of engineer training and highlights the growing importance given by higher education, to the expectations of business.

Key-words: Engineering education, innovation, training for innovation, curriculum studies, Algeria.

The authors' biographies

Rahma Sahali is a PhD candidate under the joint international supervision of the Ecole Nationale Supérieure de Management (ENSM) in Algiers, Algeria, and the Conservatoire National des Arts et Métiers (CNAM Paris) in France. Her thesis covers training for innovation in engineering education in Algeria.

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Introduction

At the beginning of the 1980s, the role of the State in technological innovation was revealed by Rothwell and Zegveld (1981, 1985) then Nelson (1982, 1984). Niosi and Faucher (1991) emphasised that the State is the main purveyor of the most important factor in production: scientific and technological knowledge. Thus, the onus weighs heavily upon higher education, at the heart of the production of scientific and technological knowledge. Some authors have shown that not just the State but the triumvirate of the State, industry and higher education play an eminent role in the development of innovation (Saad et al. 2008).

In Algeria, graduate engineering schools have a mandate from the State to bring about technological innovation. The Executive Decree n°16-176 of 9 Ramadhan 1437 corresponding to 14 June 2016 governing the standard status of graduate schools (Art.20) points out that “in terms of higher education, the fundamental mission of the school, in its field or fields of vocation is:

- to incorporate innovation, the transfer of technology and entrepreneurship in not only research but also training;
- to introduce the students to innovation and entrepreneurship”.

In the political sphere, innovation training is considered as being an important objective for Algerian schools. How does this sit with the schools? In a context where higher education in most countries, especially Africa (Charlier and Croché 2010), including Algeria (Gardelle et al. 2017), now has an international outlook, engineering schools have seen multiple injunctions, standards and trends. Among them, the injunction for innovation has been received and interpreted very differently by the pedagogical stakeholders in engineer training. This article examines how innovation training projects are produced, interpreted and negotiated in engineering schools by the pedagogical stakeholders. By analyzing their attitudes, debates, and the stresses and strains experienced by these stakeholders, this work aims to paint a nuanced picture of the way in which the teachers and heads of education receive, interpret and put into practice the dictates on innovation training or how they themselves create and produce the standards.

This study, led between 2018 and 2019, is based on a qualitative survey composed of 19 interviews of teachers and heads of education of two of the most prestigious engineering schools in Algeria.

This article is organised as follows: in Section 1, we will review several research contributions which throw light on the question of engineer innovation training. Then, in Section 2, we provide an insight into the research methodology. Section 3 presents the very diverse interpretations of innovation, the objectives of the stakeholders concerned, as to their mission to train engineers, and finally the driving forces that they identified as being behind their ambition, that we observed in the schools. In the concluding section, we will discuss the question of the adoption and production of standards within Algerian engineering schools. We will also see how innovation training is interpreted as a mission serving companies and the market – which is at odds with the objectives held by the Algerian State over the last few decades that engineers should serve the state and contribute to national development (Benguerna 2004). We shall see that this is different to what can be identified in other North African countries where the expected end results are more diverse.

1. Innovation training: a standard in engineering schools

Innovation and Higher Education in Algeria

According to some authors who work on innovation systems (Edquist 1997), the basis for innovation in developing countries is mainly the production and spread of knowhow and knowledge. The true producer (supplier) of this knowhow and knowledge is higher education. The stakeholders in this sector are in continuous interaction with other stakeholders within the framework of what is referred to as “the innovation system” (Ibid.).

The innovation system is the network of institutions in the public and private sectors and the activities and interactions which initiate, import, modify and spread new technologies to produce innovation (Freeman 1987). Its performance in terms of innovation depends on the efficiency of the interactions between the different stakeholders who are the government, academia and industry (Archibugi and Michie 1997). These interactions can be analysed thanks to a “triple helix” approach which enables the identification of a three stage evolutionary process: statist, laissez-faire and hybrid (Etzkowitz et al. 2000).

Mohamed Saad et al. (2010) conducted research which showed that Algeria corresponded to the “statist regime” in which higher education establishments are supervised by the authorities and carry out government programmes. However, our study will demonstrate that in fact, on the ground, the State influence on schools is not that assertive.

Innovation training in engineer training

Since Schumpeter used the term “innovation” in the 1934 edition of his work “The Theory of Economic Development”, innovation has gone through several stages of theoretical development. Innovating is usually associated with the idea of studying and acting so that a new activity finds its place in the technological, economic and social environment. For Françoise Cros (2009), the social use of the word ‘innovation’ seems to suit everyone as it can fit into many paradigms as long as it is bestowed with the attributes which correspond to that line of research.

The theme of engineer innovation training is frequently found in engineer training literature. It is particularly common in international journals such as the *European Journal of Engineering Education*, *International Journal of Engineering Education* or the *American Journal of Engineering Education*. The authors who refer to engineer innovation training most frequently approach the subject through pedagogical practices, by analyzing training means and trying to improve them. Few authors analyse the injunction itself, the reception of this dictate to train for innovation and how the stakeholders handle this in the field.

According to Denis Lemaître, in higher educational establishments, the injunction for innovation is most often received and interpreted from a double perspective: it is a matter of making students innovative whilst innovating pedagogically by breaking with previous educational practices (Lemaitre 2018). Thus, the teachers seek to produce new effects on the behaviour of their students, bringing them knowledge, their way of working, their representations or values, through new training methods which are adapted to these aims (Ibid.). That is what is widely reflected by the literature on innovation training; “how to innovate” is distinctly more commonly tackled than “why” (Lemaitre 2018).

Yet, innovation injunctions generated by the decision-making powers that be, are interesting to examine as to their socio-political ends, and the views of higher education and its role in society. Moreover, the analysis of the reception of these dictates by the different stakeholders, on different levels, enables the comprehension of the associated debates and the identification of profound dynamics.

Engineering schools in Algeria and what is at stake

The creation of the Algerian engineering school system was initially based on the very selective French “grande école” model, dedicated to training engineers for the State, then engineers for industry (Benguerna 2007 ; Kadri 2015). Even if, during the 1970s, the Algerian system was also influenced by the USSR and the American model (Kadri and Benguerna 2014; Kadri 2015), it has remained mostly faithful to the French model based on schools and engineering departments in universities (Gardelle et al. 2017). The graduate schools in Algeria admit students through competitive entry examinations after two years of preparatory classes, and train modest cohorts (between 150 to 300 graduates per year). Although Algeria has reformed its higher education system within the framework of the Bologna Process (Law on the Orientation of Higher Education of the 17 August 1998 and its enforcement by the Executive Decree of 23 August 2003), the engineering schools have remained outside these reforms, being considered as protected spaces, destined to train the elite (Ibid.). The schools that we have chosen to study for this work are two graduate schools often considered as being the most prestigious in Algeria, the Ecole Nationale Polytechnique (ENP) and the Ecole Supérieure d’Informatique (ESI), both of which are in Algiers.

The Ecole Nationale Polytechnique started life as the Institut Industriel d’Algérie in 1925 and has changed names several times since then. With the Decree of 25 June 1963, it became the Ecole Nationale Polytechnique which aimed to “train the technological elite which shall take charge of the economic development of Algeria” (Benguerna 2004 p.11). Very quickly, these engineers “of the challenge” were given the first industrial projects to manage in the steel, petrochemical, electricity and mining industries (Ibid.). Today, the aim of the school (which appears on the prospectuses) is to “train engineers to an international standard in high technology and who are of great flexibility” in 13 specialisms : automatics, electronics, electrical engineering, chemical engineering, civil engineering, environmental engineering, industrial management, mechanical engineering, mine engineering, hydraulics, metalworking, QHSE (Quality, Hygiene, Safety Environment) and innovation management.

The Ecole Supérieure d’Informatique was created in 1969 under the name of the Centre de Recherche en Informatique (CERI), which then changed to the Institut National de formation en Informatique (INI) in 1983 and became the Ecole nationale Supérieure d’Informatique (ESI) in 2008. The aims (stated in its prospectuses) are “to train engineers who are able to resolve complex problems alone or in teams, within organisations whilst

taking into account technological change”. After the preparatory training (2 years in integrated preparatory classes), the students undergo competitive selection to follow one year of a core curriculum and two years of specialisation. They have the choice of three specialisms: Information and Technology Systems, Informatic Systems and Informatic Systems and Software.

The aim of training innovative engineers never fails to pervade the atmosphere of these engineering schools. The objective of this article is to shed light on what is occurring in these schools as to the nature and origin of the standards relative to innovation training, the reception of possible injunctions, their interpretation, the meaning they are given and the resulting practices. This study shows that the dictates emanating from the decision-making bodies of the State do not appear to be the driving force behind the practices and attitudes of the teachers and heads of education of the Algerian graduate engineering schools, the objectives of which have shifted, not due to uniquely national factors but to the standards shown by a world movement where engineer training must boost innovation. They have adopted and taken possession of these standards, driven by the desire to train engineers who satisfy the requirements of Algerian companies and the needs of the national market.

2. Methodology

The results presented in this article are the findings of a survey conducted within the framework of a thesis on innovation training in Algerian engineering schools. This thesis is part of an international research project on engineer training in North Africa (the RIIME Project¹) which also extends and completes a project led by different research teams in Europe on engineer innovation training (Innov’ing 2020²). The general aim is to compare different visions and expectations concerning engineer innovation training in several countries around the world, understand curriculum modification phenomena and see if models become apparent in terms of engineer innovation training.

The study used as a basis for this article was composed of a series of interviews with stakeholders in higher education from the two schools in Algiers. 19 semi-directive interviews were conducted. They enquired about the goals of the engineer training delivered, as seen by the interviewees, their participation in the creation of the curricular options and their

¹RIIME : Research on Engineers and Innovation Training in the Maghreb faced with Environmental Issues, project financed by French, Moroccan, Algerian and Tunisian Multilateral Cooperation for 3 years (January 2018 to December 2020).

²INNOV’ING 2020: Engineers and innovation: new professions, new training, project financed by the French Agencenationale de la Recherche (ANR between January 2015 and December 2016).

implementation, their own pedagogical practices and the place of innovation training on different levels (expected goals, creation of curricular offers and the pedagogical means put in place). The informants in this study were chosen because they hold positions of responsibility in these engineering schools (director, dean of studies, heads of education) and/or they are teachers (see Table1). The interviews were recorded, transcribed and analysed.

This work pertains to the sociology of the curriculum. In line with the works of the British sociologists –Basil Bernstein (2007), Michael Young (1971) – and French authors such as Forquin (2008), Mangez et al. (2008) or Lemaître (2009), the curriculum is considered to be a process covering the selection, structuring and transmission of knowledge and not as a fixed product which is limited to one programme of study which merely requires description. The sociology of the curriculum pertains to the sociology of education which seeks to study social stakes and those types of social transaction which are at work in the field of education. What visions of innovation training can we identify in the schools? To what ends? What is the underlying logic? How are standards created, received or renegotiated in the schools?

By analysing the speech of the different stakeholders interviewed and the concepts they express, we were able to identify different representations of the meaning of innovation training and the degree of importance it holds in relation to other training aims. We sought to identify the representations and concepts of innovation expressed by the practitioners, teachers and heads of education when they described and reflected upon their aims. Our intention was not to identify external factors which would determine practices from an angle of cause and effect, but rather our approach aims to understand the logic of meaning revealed in their speech and which explains and legitimises the choices made and the practices. Consequently, the interviews do not only reveal information on the practices but above all they also represent opportunities to study the expression of personal positions and the generation of meaning in relation to ideological orientations and different social reference models. Thanks to the analysis of their interviews on engineer innovation training, the reference frameworks and contradictions present within the institutions can thus be identified.

3. Findings

a. Very diverse concepts of innovation

The rhetoric of innovation that we obtained from different people is rich and diverse. The teachers and heads of education expressed the meaning they gave to innovation in different ways.

Innovation seen as a springboard to economic growth

From our study, we observed several representations of this concept which differed according to the position occupied and the field of expertise of the person within the school. For the heads of the curricula that we met, innovation was a contribution towards a chain of value. Training engineers for innovation represented an objective in schools of higher education as, for these heads, innovation was considered to be a pillar of the national economy. It was considered to be an important element in the economic dynamism of companies in a marketing approach as it was a means of creating added value.« Innovation is the creation of value. If it doesn't have value, then it is not an innovation. The definition of innovation for me is, if you have an innovation and you don't manage to create value, then it isn't an innovation”, declared a lecturer at ENP. Training for innovation was to contribute to the development of the industrial world and socio-economic sector, stated a lecturer at ENP:”innovation is an important element as much in Algeria as in other countries of the Maghreb, which enables the national industrial fabric to mix with the higher echelons to some extent.” This approach, which we could consider to be somewhat neo-liberal, focuses on market requirements and the productivity of companies. In this vision, the expectations concerning innovation are techno-economic, without any real consideration of the social dimension.

Innovation and the engineering career perceived as being inseparable

Others among our interviewees considered innovation to be inseparable from the very definition of an engineer. For a lecturer at ENP, “it is that an engineer, the word itself stems from the word “genius”, is supposed to be creative and innovative”. Thus, training for innovation is not considered to be a new objective but as an aspect inherent to the training of engineers through its very definition. From Renaissance Europe onwards, the engineer has often been considered to be an innovator, being both a wise and creative being (Lemaitre 2018). In this spirit, training for innovation, for the coordinator of the Technology and Innovation Support Centre, was quite simply to train good engineers, with an intellectual capacity emphasizing ingenuity and creativity.

We also find the idea that innovation is strongly linked to technical applications and the solving of circumscribed problems. “He should innovate in one way or another and perhaps invent new tools to be able to improve the efficiency of the company and make it more competitive”, announced a lecturer at ENP.

Innovation as a new method of organisation

The teachers we met who held positions of responsibility in education stated that innovation was also organisational and not purely technical, as revealed by this teacher: “innovation is not just technological but also concerns practices”. This definition is in accordance with the proposal in the European Union Green Paper on Innovation: “innovation is taken as being a synonym for the successful production, assimilation and exploitation of novelty in the economic and social spheres. It offers new solutions to problems and thus makes it possible to meet the needs of both the individual and society.”(Mercier-Laurent 2011).

The humanist concept of innovation

Having a similar view to the above, the teachers holding positions of coordination insisted that innovation should serve society in general, in a humanist concept: “first it serves human beings” so it is created by and for human beings, and especially for society as a whole. This is in accordance with the definition proposed by Typhaine Liu (2015) for whom “the innovator must have not only a global vision of past, present and future society, but also an understanding of the different levels on which groups and organisations function”. In this view, through his activity, the engineer must serve on a higher plane. He should improve the quality of life of the population. “Innovation should bring concrete solutions to concrete problems in a new way. When I say new, this does not necessarily mean on an international scale, it can be new on a local level” declared a teacher at ESI. Here we have a view of innovation which is expected to correspond to a society and its specific requirements. We could talk about “situated” innovation, referring to a precise context, which has its particularities, as has been shown in the publications on engineer training in other countries such as Vietnam (E. Cardona Gil and D. Lemaître on Vietnam, 2017) and Morocco (Gardelle 2018).

Consequently, innovation has different meanings for the people interviewed, from concepts tied to the expected economic interest of innovation, to others concerning the

technical aspects of innovation, or even insisting on the expected social and organisational aspects.

b. Goals : training which serves companies

After having identified the different concepts of innovation expressed by the interviewees, we sought to reveal the final goals that were expected by the stakeholders as expressed in their answers to the first questions they were asked during their interviews, such as “what do you consider to be the main objective that you are contributing to or trying to achieve as a teacher at ENP (or ESI)?” We were attempting to establish whether innovation held an important place for teachers in their objectives, and if so, what their goals were.

The answers to this question were diverse. We grouped them into 4 types of goals, some stressing the importance of innovation training and others not.

Goal 1: train immediately operational engineers

With changes in the world of work and technological development, companies demand engineers who are immediately operational, flexible, able to integrate the world of work rapidly upon leaving school and able to take up managerial responsibilities. They should know how to communicate and interact with clients, colleagues and other contacts. A teacher at ESI declares that «in addition to this technical skills package companies expect other skills, obviously in relation to project leadership, communication, team integration, so we train our students in this type of skill during the curriculum”. These new demands have driven schools to develop their training: the expected role is the preparation of the necessary human resource, able to integrate the professional world rapidly and satisfy the ever evolving labour market requirements: according to a teacher from ESI “there is a strong demand for certain specialisms and careers on the labour market, so we are right in there. We are currently updating all our programmes, the idea being to start from the careers which are in demand on a national and international scale”. In this spirit, training engineers closely linked to satisfying company requirements is the driving aim of the training. The teachers who expressed this view of the final goal did not refer to innovation training as the main objective to be met.

Goal 2: training flexible engineers

The second goal widely expressed by the interviewees was the flexibility of their students “even if we train engineers in electronics, electrical engineering and mechanics...they remain

flexible in their speciality, that is to say, we give all our engineers the capacity to reflect and analyse in their own field” said a teacher at ENP. They aim to train engineers who are “captains of industry” as another ENP teacher explained, “The Ecole Polytechnique is not going to train a standard engineer. The aim is to train engineers who are captains of industry”. They must bring solutions to the diverse problems that companies have to confront “companies expect engineers who can solve their problems efficiently. They have problems, on-going projects, developments, infrastructures to manage, projects to manage, so all of that is the role of the software engineer. He is the one who solves those problems in an efficient way”. For the teachers who declared that this was their objective, innovation was not considered as having a central position.

Goal 3: train entrepreneur engineers

We also found that for those interviewees who were responsible for innovation generating facilities (incubators), their declared objective was to train students for innovation for entrepreneurship. The lack of job offers in Algeria has led teachers to prepare student engineers in entrepreneurship and company creation which they consider to be a source of job creation. Their training is entirely geared towards this aim, including entrepreneurial activities throughout their curriculum: “we aim to train job creators not job seekers, that is to say that the engineer when he has finished can fly with his own wings and become an entrepreneur and create his own company” declared a teacher at ENP. To do so, the school gears their innovation training towards the students creating their own start-ups: “by adapting the programme, you need to encourage them to create their own companies and be entrepreneurs”, declared a teacher from ENP, “That enables the student to innovate, not to join the unemployment register but to create a job. He will create the job, create his own start-up...”

Innovation has its role to play towards this goal which the teachers and heads of education strongly endorse. This goal is realised with the help and support of the school directors who encourage these activities and facilitate their application. The example of the specialised course “Management of Innovation” at ENP is a good example. It is a course especially dedicated to innovation. This specialism was introduced 7 years ago and the remarks of one teacher on this point are a good illustration of the position of the teachers as a driving force behind this initiative, and the support they receive from the directors of the school: “When we were asked to integrate the consortium, it was the department which decided and the directors

which supported and followed it but the idea came from us. They never said no, don't do this and don't do that. We decided to open the innovation course, we did it, I mean, it's complementary, it is not strictly the directors or the teachers but the ideas come from one or the other". A teacher from ESI confirmed that the management of their school is also considered to be encouraging "the directors gave us carte blanche to do that".

Goal 4: train engineers serving society

Finally, according to some teachers interviewed, it is the context, the environment, the evolution of local and national situations that will force organisations to innovate to survive. Environmental changes in the broad sense of the term, will require changes to be managed. Consequently, training aims to promote the capacity of engineers to satisfy the demands of the environment, and within this framework, innovation training is considered to be essential by teachers who coordinate units dedicated to innovation: innovation "is something that the environment and its evolution has forced upon us", said a teacher from ENP. With this in mind, innovation training satisfies the requirements of society in general (and not merely the expectations of companies) by bringing progress which gives meaning to society (Akay 2003; Cardona Gil, Gardelle and Tabas 2018): "innovation should serve society. It is not just a question of training and training to obtain diplomas, it really is to satisfy the needs of society. That is why, on an academic level, the school is the first to create an incubator within it to accompany and encourage start-ups, student ideas, and to mature and develop them" said a teacher from ENP. From this point of view, the beneficiary has a much broader profile as this is the whole of society. Serving society appears to be the driving force of this goal. The minister for industry with whom the school has a close relationship, is quoted by one teacher as being an aid, a facilitator for this training. Not many quoted him as being a driving force.

Table 1: The different goals raised concerning engineer training and its beneficiaries

Goals expressed		People who expressed this objective	Beneficiaries mentioned
Innovation training	1. Train operational and flexible	- Teachers - Head of training	Companies

	engineers who will easily fit into the world of work	<ul style="list-style-type: none"> - (Management of Innovation option at ENP) - Head of the incubator at ENP 	
	2. Train flexible engineers with open minds, and overarching vision, capable of tackling complex problems	<ul style="list-style-type: none"> - Head of training (Management of Innovation option at ENP) - Coordinator of the Technology and Innovation Support Centre at ENP 	<p>Companies</p> <p>Directors of the school</p>
Innovation training considered to be important	3. Train innovative engineers and job creators	<ul style="list-style-type: none"> - Teachers - Head of the “Master” support cell of ESI - Head of the incubator at ENP 	<p>Economic dynamism</p> <p>The demands of globalisation</p>
	4. Train innovative engineers who can satisfy the needs of society and its evolution	<ul style="list-style-type: none"> - Coordinator of the Technology and Innovation Support Centre at ENP 	<p>Companies</p> <p>Society</p>

This table summarises our results concerning the training goals of the two schools studied and their target beneficiaries as expressed by the different stakeholders interviewed.

Table 2: List of interviews accomplished

Engineering schools	City, creation date	Number of students trained per year	People met
Ecole nationale polytechnique	Algiers 1925	289 engineering graduates and 239	<ul style="list-style-type: none"> - 9 teachers - Dean of Studies * - Head of Training*

		Master graduates in 2017	<ul style="list-style-type: none"> - Coordinator of Technology and Innovation Support Centre at ENP* - Head of the Incubator at ENP*
Ecole supérieure d'informatique	Algiers 1969	An average of 180 graduates per year	<ul style="list-style-type: none"> - 10 teachers - Director* - Director of External Relations* - Head of the FIE (entrepreneur) Training* - Head of Internships*

* Also teachers

This table presents the two schools in which the interviews took place, their cities and creation dates as well as the people who were interviewed.

According to what we have identified in our study, the teachers and heads of education indicate that the training that they are working towards is almost exclusively inspired by, planned for and set up with companies. This analysis of the interviews shows that the teachers and heads of education do not state that they are obliged to answer the injunctions of the Ministry in terms of innovation training. There is no strong implementation of the injunction imposed from on high or by an accreditation agency such as the CTI in France, the ENAEE in Europe (with the EUR-ACE label), or the ABET in the USA, requiring schools to train for innovation. We observe that it is the teachers themselves who fix objectives through adopting the approach and they mobilise the expectations of companies, national economic dynamics and also the need for globalisation and the requirements of society. Admittedly, there have been some attempts to integrate European accreditation standards such as the EUR-ACE label (especially through the MEDACCR project on quality assurance in the Mediterranean) but this has remained quite limited. Only two Algerian schools are concerned (the Ecole Nationale Polytechnique d'Oran and the Ecole Nationale Polytechnique de Constantine).

This study also shows that innovation is not seen as a priority in these engineering schools. According to the interviews, we see that in the elaboration of training programmes, innovation is not seen as indispensable. The final goal of these schools is to train competent engineers technically speaking, and the other aspects such as innovation, take a back seat. According to the teachers and heads of education that we met, it is important to train innovators but that does not override the other objectives that we have mentioned, such as training engineers who are immediately operational on a technical and managerial level, or training flexible engineers capable of an overarching view, and future “captains of industry”. That was confirmed by all those interviewed except those who taught modules which were directly concerned with innovation and a few other heads who were above all in charge of external relations. The latter stressed the interest of innovation as they were generally the link between the school and the industrial and economic world. Consequently, they were well informed of the dynamics on an international level, especially the widespread attraction for innovation training, and they were looking to promote their establishment.

If we compare these results with those of other North African countries, we observe the research objectives are markedly different in a country such as Morocco. The common point is that, like in Algeria, in Moroccan engineering schools, innovation is considered to be secondary. It is not one of the main preoccupations of the pedagogical stakeholders in these schools. However, unlike Algeria, we find an aim to train engineers in innovation in order to improve the everyday lives of the Moroccan people (Gardelle 2018). The innovation required is thus “situated” which, through its particularities, must suit a Moroccan context (Ibid.).

Although Algeria and Morocco are two countries which are similar in many ways (social and environmental stakes...), their dynamics remain very different and deserve to be analysed to be able to comprehend what is happening in higher education and the effect international and European standards are having as they spread throughout the world. Some authors have shown that Algerian higher education is heavily dependent on the State, as there are not many other stakeholders (Saad et al. 2010) but we have observed that engineering schools are islands which stand apart and in which the teaching staff act in a very autonomous manner.

4. Concluding section

One of the important revelations of this study is that on a political level in Algeria, there are no strong injunctions for innovation training. Although there are institutional texts as

we saw in the introduction to this article, which suggest innovation training in graduate schools, there are no coercive measures or restrictive frameworks, contrary to other countries in the world, where the dictates are much stronger. This is the case in Europe, for example, with the rulings of the H2020 European programme (report of European Commission, EACE/EURYDICE, Entrepreneurship Education at School in Europe) relayed by national bodies such as the CTI in France (Jolly and Nolland, 2018). The teachers and heads of education in the Algerian engineering schools who expressed a desire to train their students in innovation take this objective upon themselves. This can be explained by the influence of their monitoring of what goes on in engineer training elsewhere in the world, especially in France, towards which many feel close ties due to historical heritage and cultural and linguistic proximity.

The standards leading to engineers being trained for innovation are largely present in engineer training worldwide, as demonstrated by literature and especially the publications of journals such as the *European Journal of Engineering Education*. Even if these have not been imposed upon the Algerian engineering schools, they have introduced themselves and the teachers have seized upon the rhetoric. The words of the ESI teachers are a good illustration of this: “The explanation of this is that we do not live on a deserted island, and everywhere in the world this is what makes things advance and we should not remain on the touchline. We speak of globalisation, we are in a world without borders as far as everything that happens in technological progress is concerned [...] so it is normal, either we take the train or we remain in the station” said a teacher at ENP.

Our research has also revealed the existence of several innovation training philosophies which can rub shoulders or even compete. In the schools, these objectives have the potential to complement one another rather than compete, by being set at different times during the curriculum. On a pedagogical level, how can training courses be developed which enable these different objectives to come together as effectively as possible? That could be the subject for future research applied to different contexts (Algerian or others).

Another important result of this study is that the priority expressed by the teachers in these schools is not to train for innovation. Certainly, some of them have adopted this standard, some of them make real efforts to do so, but many teachers remain convinced that innovation training is of little importance. For some teachers, the priority is to give training in operational technology, or flexibility and for others to train future “captains of industry”.

Finally, we finish by highlighting the regret expressed by a large number of teachers in these prestigious Algerian schools. As we have pointed out, the beneficiaries of their efforts to train those that they consider to be good engineers are mainly companies. The teachers, the heads of education, the directors express the wish to see the graduates that they train serve Algerian companies and play a part in economic dynamism. Yet, our interviewees confided in us their disappointment at seeing their graduates move abroad en masse once they have obtained their diploma. This loss of engineers bothered a large number of teachers as they considered that they were training engineers for the benefit of other countries, especially in Europe, and not for the benefit of Algerian companies. One teacher confessed: “The first challenge that nobody has taken up, is not a training problem. Currently, we are training for others” [in particular for Europe].

Very different from the « precursor » engineers in Algeria in the 1960s, who with their diplomas still hot in their pocket, said: “There, I’ve done my studies, I will serve my country” (Benguerna 2004 p.10), large numbers of young graduates are now choosing to emigrate for their studies or to find a job. The reason for this emigration is the political, social and economic situation (Gardelle and Benguerna 2015). In this context, the engineering schools that we have studied are a step towards a professional and life project. As a teacher of ESI said “the young people come here because they have more possibilities to leave, it is not because they have a calling for informatics. We are just a bridge”. Faced with a very high departure rate (80% to 90% of graduates in a cohort according to the teachers questioned), it is difficult for the teachers in these schools to see their efforts as participating in the national technological development that the government called for in its 2016 decree concerning innovation training in engineering schools.

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