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Algerian Engineer Training at a Time of Major Environmental Challenges:

A Survey of Three Graduate Schools

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Abstract

Environmental problems are having a brutal impact on the daily lives of the North African population. These countries have a young population, with significant numbers in higher education. Given this context, are future graduates being made aware of environmental issues? Since future engineers are the creators of tomorrow's technological and socio-technical changes, an analysis of their training is of particular interest. This article explores the ways in which choices are made in programme creation and what influences changes in three engineering graduate schools in Algeria. Through a curriculum sociology approach, we examine how curricular offers are discussed and implemented at a time when major environmental constraints weigh heavily on Algeria. We analyse higher education policies on engineer training, as well as the construction of programmes, via an analysis of the programmes themselves and interviews with 24 stakeholders. The article shows that in the absence of instructions imposed by political decision-makers, teachers enjoy a remarkable amount of freedom when creating curricula. However, tensions arise since there is no authority to arbitrate disagreements. The results open avenues for further reflection for researchers interested in macrosociological reconfiguration in higher education.

Key words: engineer training; environment; curriculum; Algeria; macrosociological reconfiguration

1. Introduction

Environmental problems (desertification, ground and air pollution, etc.) are having a brutal impact on the daily lives of the Algerian population. Algeria has a young population, with 53% of its inhabitants being below the age of 30 (Meyer, 2019), and 43% of these young people in higher education (according to the Ministry of Higher Education and Research, in 2019, 1 469 984 students were enrolled in university). In the near future, this young population will confront the major environmental challenges looming on the horizon. The type of training students receive in scientific and technical subjects, including engineering, is crucial, as once they graduate they will be expected to address major national socio-technical challenges. While Algeria has experienced numerous economic and political challenges in the past few years, environmental issues cannot be ignored as these issues are inter-related.

Given this context, is there awareness of these serious issues in Algerian higher education? Are efforts being made to prepare future graduates, especially engineers, for the major environmental challenges to come? Given that future engineers are the creators of tomorrow's technological and socio-technical advances, it is important to establish the extent to which their education prioritises environmental issues. What does training engineers for environmental challenges mean for teachers and heads of training in engineering schools? These questions have been explored in Europe in the past decade (*CEFI*, 2010; Holmberg and al., 2008; Prevost and Jouffray, 2013; Segalàs and al., 2009; Villette, 2018), with less attention in other parts of the world, especially Africa.

This article explores the conception and review of training programmes in three Algerian graduate engineering schools, the Ecole Nationale Polytechnique (ENP) Ecole Supérieure d'Informatique (ESI) and the Ecole Nationale Supérieure Agronomique (ENSA). It is based on the results of a survey that involved curriculum analysis and interviews with teachers and

teaching heads at these graduate schools. Following a description of the environmental challenges specific to Algeria and the three engineering schools, the methodological framework is presented, followed by the study's results.

2. Algeria's Major Environmental Challenges

The global natural environment has been deteriorating for many years (Flipo, 2007; Ghouati, 2016). Environmental issues such as pollution, climate change, and water scarcity are becoming increasingly acute. Less developed countries are the most affected (Hugon, 2005). Research has shown that environmental damage in Africa is becoming progressively worse (Ghouati, 2016). While Algeria has promulgated a number of important pieces of legislation in relation to the environment in the past 50 years, depletion of natural resources continues (Demri, 2010).

2.1. Desertification and Pollution

The natural environment in North Africa has been damaged for many years (Ghouati, 2016; Mansour, 2012). Algeria is the largest country in Africa, with 87% of its land being desert and its large population being unevenly distributed throughout the territory. The Office National des Statistiques (2017) (National Office for Statistics) forecasts that the population, which was estimated at 43.3 million in 2020, will reach 51 million by 2030. Agricultural land is diminishing due to increased urbanisation and water resources are limited. The number of uncontrolled waste heaps is increasing as dietary habits change and the population is producing more household waste which is not efficiently managed. The coastline is constantly being degraded due to seawater pollution, silting and housing construction (Mansour, 2012). Unfettered agriculture has added to ground and water pollution. Finally, despite the "great green wall" set up in the 1970s, the desert is gaining ground and less land is suitable for agriculture or livestock farming (Ghouati, 2016).

2.2. The State's Response to Environmental Issues

The Algerian state has been involved in environmental questions since the country's independence in 1962. Since 1963, it has adhered to the International Convention for the Prevention of the Pollution of the Sea by Oil (OILPOL). In 1972, it participated in the first global conference in Stockholm under the auspices of the United Nations and in 1974, the government established the Comité National de l'Environnement (National Committee for the Environment) to design the essential elements of environmental policies within the framework of national planning, economic and social development strategies (Demri, 2010). Algeria was one of the first countries to establish a legal framework for the protection of the environment in 1983. Following a summit in Johannesburg, the government formulated the Stratégie Nationale de l'Environnement (SNE) (National Environment Strategy) and the Plan National d'Actions pour l'Environnement et le Développement Durable (PNAE-DD) (National Action Plan for the Environment and Sustainable Development) in 2002.

A raft of national plans in relation to the environment was implemented between 2000 and 2010, the results of which have yet to be examined. They included the Schéma National d'Aménagement du Territoire (SNAT) (National Development Plan); the Programme de Développement des Energies Renouvelables et l'Efficacité Energétique (PDEREE) (Renewable Energies and Efficient Energies Development Programme); and the Plan National Climat (PNC) (National Climate Plan). Algeria is currently guided by its Stratégie Nationale de l'Environnement et du Développement Durable (SNEEDD 2019-2035) (National Environment and Sustainable Development Strategy 2019-2035).

However, implementation of these policies and programmes has left much to be desired (Bouabdesselam and al., 2015; Mellakh, 2011). The economic and political crisis, strong

population growth and increased industrial, social, economic and climatic constraints have meant that environmental challenges are more evident than ever before.

Over the years, environmental issues in Algeria have been the responsibility of different ministries, including the Ministère de l'Hydraulique (Ministry for Hydraulics) in 1977 and 1984; the Ministère de l'Intérieur, des Collectivités Locales et de l'Environnement (Ministry for Domestic Affairs, Local Authorities and the Environment) in 1994; Ministère de l'Aménagement des Territoires et de l'Environnement (Ministry for National Planning and the Environment) in 2000 and the Ministère des Ressources en Eau et de l'Environnement (Ministry for Water Resources and the Environment) in 2015. In 2017 the Ministère de l'Environnement et des Energies Renouvelables (Ministry for the Environment and Renewable Energies)¹ was created. It is tasked proposing elements of national policy in the fields of the environment and energies. The continual shifts in responsibility suggest that the government lacks conviction and assertiveness in dealing with these issues.

A governing body dedicated to raising environmental awareness and education is part of the new ministry. Algeria was a signatory to the first Convention sur la Conservation de la Nature et des Ressources Naturelles (Conservation of Nature and Natural Resources Agreement) signed in Algiers in 1968 under the auspices of the Organisation of African Unity, which included a commitment to integrate environmental issues into training programmes and scientific and technological research (Ghouati, 2016). This agreement was updated in 2003 (Doubé-Billé, 2005), with the new version also recommending that environmental issues be integrated into training programmes. The key aim of this article is to examine whether this has been taken on board in the context of engineer training.

¹ Actually, Ministry for the Environment

3. Changes to Engineering Curricula in Higher Education

As part of an international research project on engineer training in the Maghreb (North West Africa) in the face of environmental challenges (the ANONYMISED Projectⁱ), we investigated the socio-historical development of engineering training in Algeria in the 20th century through empirical interviews in engineering schools.

3.1. Engineer Training in Algeria in relation to political changes

Technical higher education was almost totally inaccessible for Algerians during French colonisation. Following independence in 1962, Algeria implemented a development project for engineer training and created schools and institutes for this purpose. Numerous initiatives were launched to improve engineer training to serve the needs of industry (Benguerna, 2004). The project was influenced by the Soviet model which was primarily based on heavy industry and the production of capital goods (Longuenesse, 1991). However, the training has also been influenced by the French model (Gardelle, 2017).

Towards the end of the 1970s, different engineer training institutions were established to train high level executives (Haddab, 2014) and thus promote Algeria's technical independence (Ali Benali, 2014). This has been referred to as the "golden age of engineers" (Haddab, 2014). However, the economic crisis in 1980 reduced employment opportunities for engineers.

Engineer training in Algeria is the exclusive responsibility of engineering graduate schools which offer three to five year scientific and technical training programmes. Some schools recruit their students through preparatory classes, and others after the Baccalauréat (equivalent to the High School Certificate) in schools where preparatory classes are integrated. Selection for these schools is highly competitive.

Our study, which adopted a comprehensive, qualitative approach rather than a statistical one, involved three graduate engineering schools in Algiers: the ENP, ESI and the ENSA. These renowned schools train engineers for several different sectors over a period of five years (hydraulics, civil engineering, electrical engineering, computer science, agronomy, metallurgy, forestry and so on) and were among the first to be established in the country. The ENP is a graduate school which was founded in 1925 and was one of the first Algerian engineering schools based on the French academic model. To date, it has trained about 8 000 engineers. The ESI was established in 1969 under the name, Centre d'Etudes et de Recherche en Informatique (CERI). It has trained almost 6 000 engineers who work in different sectors such as industry, energy and telecommunications. The ENSA was launched in 1905 and has trained almost 5 000 agronomist engineers since 1962.

In the time since these schools were established, the country's industrial and economic characteristics have evolved, and so too have the training objectives. Among other things, the latter have shifted from training post-colonial development leaders, to producing engineers to drive industrial growth and lead innovation. In modern times, when the world and Algeria in particular faces major ecological and environmental challenges, have the curricula and training objectives taken environmental awareness on board? This article examines the three schools to establish whether or not this is the case and if so, how they have done so and for what reasons.

A Methodology

The research that underpins this article was conducted as part of a doctoral thesis on the purpose, content and pedagogical approach of Algerian engineering schools with regard to environmental challenges.

As part of the educational sciences, curriculum sociology considers the curriculum as a process that encompasses the selection, structuring and transmission of knowledge (Bernstein, 2007; Forquin, 2010; Young, 1971). It studies the stakeholders and types of transactions at play in the field of education in order to understand how programmes are conceived. This calls for an examination of the debates surrounding their creation and reworking in response to dictates and expectations, what governs their content, and to what end. As part of this research, we analysed the higher education policies pertaining to engineer training via official documents, media reports and ministries' websites, as well as the construction of the programmes, via content analysis of the programmes themselves and interviews with stakeholders involved in their construction. Interviews were also conducted with directors and heads of department within the Ministry of Higher Education and Scientific Research (Gardelle, Amdouni and Djennadi, 2022).

This article explores the reworking of curricula by focussing on the meaning stakeholders' give to the work of constructing programmes, and their results in three Algerian engineering schools. We explore how curricular offers are discussed and implemented in the schools at a time when major environmental constraints weigh heavily on Algeria.

Twenty-four semi-structured interviews were conducted with teachers and teaching heads in the three schools between 2018 and 2020. To select the interviewees, we identified lecturers who presented modules that included the environment to a greater or lesser extent. The interviews focused on their academic education and career paths, their current positions and their major teaching objectives. We then examined the objectives and contents of the modules they directed or taught in order to ascertain the importance assigned to environmental issues. The interviews also revealed their daily work experiences, and their assessment of the extent to which they had achieved their teaching objectives. Discourse analysis was employed to

determine the motives behind the creation of lessons concerning the environment, the driving forces, their characteristics, and any contentious issues relating to their creation, development and implementation.

4. Results

The empirical survey revealed the objectives and reasoning behind the construction of the engineering schools' programmes and the teachers' activities.

4.1.The Context for Programme Creation and Development

The interviews revealed that the teachers in the three engineering school exercised autonomy in defining their objectives and designing and updating their lesson content. However, teachers attended departmental meetings that offered opportunities to discuss their lessons.

Theoretically, programmes in all the schools are updated every three years. However, some teachers at the ESI and ENSA stated that they were reviewed every two or three years, while others at the ENSA reported that the programmes in certain departments dated back to 2002. Asked what led teachers to review their programmes, the interviewees said that they updated their programmes due to "anomalies", "obsolescence", "omissions", or "repeated criticism from colleagues, professionals, students, graduates and alumni". They were also updated as a consequence of "what happens in other places" (in other national and international establishments), "changing needs" (society, industry, companies and so on), "changing strategies", and "new technology and concepts of things". The interviews revealed that an internal force (the teacher's own initiative, awareness) drove the updating of a programme rather than an external force (injunction, directives from outside). Thus, according to the interviewees, change was driven by teachers.

In terms of process, the interviewees recounted that when teachers decided to update their programmes, they convened committees comprising those who wished to take part and set up meetings to obtain feedback and advice on improvements.

Thus, the teachers were able to discuss the lesson content, delete or add transversal material, combine or split material, and increase the number of teaching hours if necessary. It was noted that such meetings were marked by tension which the teachers referred to as “divergence of opinion”, “disparities”, “differences of opinion” and “stormy discussions”. These were attributed to “different specialisations”, “different ways of thinking”; “self-interest in relation to the total number and convenience of the teaching hours” or “skills that are mastered or not”.

We sought to determine the amount of autonomy the teachers enjoyed in creating a course offering. A teacher at the ENP stated that during programme review meetings, “all discussion is permitted so everything is debated and debatable, nothing is left out”. Other respondents agreed with this statement; however, one clarified that core lessons “were not discussed”, as they “don’t change” and that “change really occurs in transversal subjects where the lessons are optional”. The only aspect that cannot be changed is the architecture of the programmes and the total number of hours per semester, which are laid down by the school’s committee. Thus, as noted by a teacher, “in the spirit of ECTS (European Credits Transfer System training), [the structure] must be obeyed”. It was also noted that, at the ESI, “anything is open to discussion except the total number of teaching hours which is well defined, and the course offerings”. However, a teacher at the ENSA declared that “the teaching hours can change and it is the number of credits that must conform to the quota ... at ENSA, they are very flexible on that point”. We observed that although the participants in programme review meetings felt free to express their points of view, it was sometimes difficult to reach consensus.

The discourses on this issue are very similar across the three engineering schools. None of the interviewees identified constraints in the creation of course offerings, or any frameworks or directives imposed by ministries or other authorities. However, two major constraints were identified in all three schools, namely, economic constraints and a lack of or poor financial management that stifled optimal pedagogical development; and the lack of a global vision and consensus among pedagogical stakeholders. Programme meetings, to discuss lesson content were often marked by animated and sometimes endless debate between teachers with different agendas and views, with no framework in place to ensure overall consistency.

4.2. Stakeholders' objectives

Our analysis revealed that, at the ENP, teachers' main aim was to give their students an edge in terms of technological skills; the programmes enabled students master and understand the basic elements and techniques necessary in each discipline. However, the broader objective of training engineers capable of handling and overseeing multi-faceted projects that involve the environment, seemed to be lacking. This suggests that students lacked awareness and understanding of environmental issues. The environment was rarely mentioned in the programmes and, where it was, the references were contained in transversal subjects with fewer teaching hours, with the exception of the QHSE-GRI (Quality, Hygiene, Safety, Environment and Industrial Risk Management) and environmental engineering specialisations.

Does the inclusion of a few ideas about the environment here and there indicate a real desire to train engineers who will be equipped to address environmental challenges? At the ENSA, the "Forestry and Protection of Nature" specialisation covers many more themes linked to the environment than the other specialisations. Thus, some departments prioritise the environment more than others, pointing to uneven environmental training. The ESI does not offer any

specialisation or module directly linked to the environment, suggesting that it is not considered important to enlighten future computer science engineers on questions concerning the environment. The interviewees at the ESI explained that their job does not really have a significant impact on the environment; thus environmental issues are not among their concerns. In contrast, specialisations like agronomy are geared towards the protection of fauna and flora.

The findings revealed that, in all three schools of engineering, awareness of environmental issues is generated by means of experience of real-life situations through internships, activities organised by clubs, educational outings, and open days on environmental issues, among others. The Club of Multiple Activities at the ENP, Green ENSA and the Green Club at the ESI organise clean-up campaigns, tree planting days, waste sorting, seminars and open days on environmental issues. Similar student clubs have been established in the neighbouring countries of Morocco and Tunisia (Grövel, Gardelle and Bylykbashi, 2022).

The study's also found that, at the ENP, efforts are made to make students aware of environmental issues through programmes and subjects such as renewable energies, company management and sustainable development, and atmospheric pollution, while the ENSA focuses on spatial planning, water pollution, plant ecology, animal conservation, and ecology.

However, teachers in the three schools were of the view that primary responsibility for raising awareness of environmental is not the remit of engineering schools. One commented: "This idea, it should be in the students' minds, at home, their behaviour; they should be responsible for their own actions". A teacher at the ESI observed: "that's part of your being when you are a citizen and that is not among the priorities of the school".

4.3. Relationship with the Ministry for the Environment and Renewable Energies

While the institutional directives point to the Ministry for the Environment and Renewable Energies being heavily involved in training, it was only mentioned once, as a partner in the ENP's programme to train state engineers in environmental engineering. The interviewees were asked to identify their schools' links with the ministry and the activities it was engaged in. One teacher remarked that, "nothing happens, in reality", while another stated that the relationship took the form of a research partnership as the school's research laboratory is attached to the ministry. It was noted that the ministry had never participated in establishing or revising programmes.

The Ministry for the Environment and Renewable Energies was not mentioned as a partner for the programmes at the ENSA and ESI. Teachers interviewed at these schools stated that "there are no direct relations" with them and that "they do not participate in the programme review committees". The respondents at all three schools expressed negative views of the role and support provided by the ministry, noting that it did not participate in programme elaboration or review even with regard to departments with which it had signed agreements.

It can thus be concluded that the role of the Ministry for the Environment and Renewable Energies is to provide overall political and ideological direction on youth education on environmental issues, but its intervention is limited to policies and legislation. It is also apparent that its lofty principles have not yet been applied in engineer training.

The gap between theory and the reality on the ground is clearly apparent. While they expressed the desire to prepare future engineers for environmental challenges, the teachers that were interviewed noted a lack of institutional and budgetary support. Awareness raising in the three schools is limited to extra-curricular activities, or providing concrete examples to "open the students' eyes" and "gain their attention", as several teachers declared. For example, in class they are encouraged to "switch off the light", "retrieve paper left behind in

the exam room by the students”, “print recto verso”, and “switch off the air conditioning when leaving the classroom”. Teachers’ levels of awareness and their resultant practice could be the subject of future research by curriculum sociologists.

5. Conclusion

Our empirical survey showed that the main objective of the three engineering schools is not to make students aware of environmental issues. With the exception of a few specialisations, concepts linked to the environment and sustainable development are rarely mentioned in the ENP and ENSA’s programmes, while they are not part of any programme at the ESI. While the teachers’ discourse revealed a desire to instil environmental awareness among students, there is no in-depth group reflection on training objectives, no support from the Ministry for the Environment and Renewable Energy, and a lack of consensus among stakeholders.

Our interviews with teachers at these three engineering schools revealed the gap between their intentions and actual practice. While it is acknowledged that they are hampered by a lack of human resources, funding and pedagogical tools, the study revealed that teachers have significant autonomy in creating, updating and reviewing programmes. No external accreditation bodies set frameworks and, while the engineering programmes are validated by the Ministry of Higher Education and Scientific Research, it does not issue directives except in the most general terms. The situation is exacerbated by tensions within the schools between teachers and teaching heads. While other tertiary institutions experience similar tensions, they are bound by frameworks and the directives of accrediting bodies. The lack of any authority to arbitrate disagreements in the engineering schools seems to exacerbate tensions.

Based on the study’s findings, consideration should be given to the formulation of frameworks, norms, directives and certification or accreditation to facilitate the development

of programmes that enhance environmental awareness among trainee engineers. Gardelle and al. (2016) note that, engineering schools in Algeria's neighbouring countries of Morocco and Tunisia also lack support from the state to improve the training of future engineers by incorporating environmental issues (Gardelle, Amdouni, Djennadi, 2022). Future researchers who are interested in macrosociological reconfiguration in higher education, as well as institutional stakeholders could thus investigate strategies to make engineer training more efficient and relevant.

This research was conducted in three Algerian graduate schools and is not representative of all engineering schools. Future research could also investigate these issues in other engineering schools in Algeria and North Africa.

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