District–Learning: An Architectural Approach to Bridge the Academic Gap in the UAE Educational System

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Abstract. The United Arab Emirates Vision 2071 expects the country to become one of the best in the world in several sectors, including education and infrastructure. Highlighting today’s global tendency towards a knowledge-based economy, it drives the need to bridge the academic gap in UAE’s educational system to enhance the nation’s innovation. This gap is best addressed from three different levels, policy level, pedagogical level, and socio-urban level. The UAE is working on developing its educational system by emphasizing its importance through the UAE future strategies and policies, that will upgrade it with its new pedagogical facilities. This study proposes the “District-Learning”, a novel approach to upgrading the UAE educational system/sector by providing the necessary new pedagogical functions in a building located in the barycenter of a school district and serving all its existing facilities. The concept focuses on boosting the communication between schools in the same district and enables sharing resources between them. This non-physical connectivity will be translated into physical connectivity which bridge each existing school to the new building. The construction process fosters modularity and flexibility, allowing the project to fit the demand of different districts. The study present the results of a test of this new approach to the case study of Al Jurf 2 zone in Ajman.

1. Introduction

1.1. Background and problem statement

UAE’s Government aims ensuring the transmission of the knowledge, skills, and values to the next generation, seeking the development of socio-educational society and country’s future leadership. By highlighting today’s global tendency towards knowledge-based economy, there is a need to bridge the academic gap of UAE’s educational system to enhance the nation’s innovation. This gap is best addressed from three different levels, policy level, pedagogical level, and socio-urban level:

- On the policy level, The UAE is developing its educational system by emphasizing its importance through the UAE Centennial Vision 2071 [1], Ministry of Education Strategic Plan 2017-2021 [2], and the SDG (Sustainable Development Goals) 2030 Agenda [3]. In 2019, the Ministry of Education (MOE) has also launched a new set of pedagogical requirements to enhance the UAE’s public educational system.
- On the pedagogical level, there is a significant gap between public schools’ educational system and university requirements. Students should be better prepared and empowered before the transition between the school and the academic life. Moreover, there is another a major gap between public schools’ educational system and what industry demands. In public schools, large numbers of Emirati students are
not aware of their abilities and interests due to the lack of programs and facilities to assist discovering them. Consequently, a large number of students end up choosing unsuited university major.

- This outdated educational system affects the social and urban level, resulting in a large number of Emirati enrolling in private schools instead of public ones, since internationally educated employees are preferred by industry, as believed possessing better skills. This fact is already causing public schools to be demolished, converted to another function, or left unoccupied. Moreover, a large number of Emirati student chooses to study abroad to get better skills and experience, with the UK and USA being the most popular destination among Emirati degree-seeking students [4].

As a step towards improving this situation, this study proposes the functional and pedagogical school upgrade. However, differently for the conventional approach of refurbishing building for building, the “District Learning” proposal acts at the urban scale, by providing all facilities required for entrepreneurship, creative problem-solving, and career guidance in one independent building to be located in a central position to a school neighborhood, and serving them all. The ethical meaning of this approach is to provide the new pedagogical offer outside the school buildings as a statement of expanding the horizon of the students to the external community and industry.

1.2. Objectives
- Provide industry related facilities for public schools which will help to expand the horizon of students to the community. This will help them developing the skills required by the industry at an early stage in their learning path.
- Elaborate guidelines to improve the educational standards without neglecting the existing educational infrastructure.

1.3. Limitations
- A significant amount of the information was obtained through personal communication with professionals from the UAE Ministries of Infrastructure Development and Education. For this reason, there is uncertainty on the full accuracy of such data.
- Statistical data, obtained from online governmental sources, is sometimes incomplete. When comes to numerical data, the study proceeded by linear interpolation.
- This mainly concerns the public school sector, characterized by a unified system of both buildings and educational program that simplified mapping the existing school stock and proposing potential solutions. However, private schools were also considered in this study in a more parametrical way, not being able to collect the same amount of data instead gathered for the public ones.

2. Research methodology and phases
2.1. Summary of the research phases
This study uses a diachronic approach [5] to analyze the educational systems in terms of historical urban development, pedagogy, typology, and building construction, to acquire a full picture of the current scenario, and finally be able to propose a solution for its upgrade. The phases of the study were:
1. Background research of the historical development and future trends of the educational system in the UAE, including the identification of important requirements to project the sector in the “next 50 years” and meet the industry requirements. The study focuses especially on the following case studies:
   - The “School of the Future” program launched in 2016 [6].
   - The “Compact School” model started in 2016 [7].
   - The “Upgrade of the UAE school sector” (2019 [8]), an alternative to the above-mentioned new-construction proposals, suggesting the refurbishment of the public schools and presenting the test on a sample building.
2. Elaboration of the new urban approach to the upgrade of the school system and test on a sample case:
Investigating the viability of adding the new requirements to the existing school. Study the advantages and the limitation of this approach.

Investigate the viability of a new approach based on providing the upgrading facilities in a central location to multiple schools, therefore limiting the refurbishment activity on the existing buildings.

3. Background research

3.1. Historical development, future trends, and requirements of UAE educational system

Education has always been a part of the culture of people of the UAE, where in the past years people relied on self-education, apprenticeship, and interaction with others. Then, prior to union, the MOE determined four stages of the old pedagogical system, al-Mutawa and al-Katateeb, Educational Circles, Semi-Formal Education, and Modern Formal Educational system. In 1971, the MOE launched the first National Curriculum and the Ministry of Infrastructure Development (MOID) constructed schools in three “Generations”, each one comprising several building “Models” (table 1). A Model is a building prototype that is designed to be replicated in all Emirates (except for Abu Dhabi, which has a similar Model-based system but with different building typologies).

3.2. Recent initiatives to develop the education system in the UAE

Among the history of UAE, several governmental policies and initiatives were designed to bring an upgrade in the country’s educational system, with the aim of ensuring that students are consistently fully prepared to compete in the global market. The “School of the Future”, the “Compact school” model, and the refurbishment of an existing school tested in the “Upgrade of the UAE school sector”, are the most relevant recent initiatives towards developing the educational system of the UAE.

The “School of the Future” was launched as an open design competition in October 2016 by the MOID and ME. The intention of upgrading the public schools’ curriculum (as part of the country’s 2021 Vision and commitment to the SDGs) demanded the design of a new campus-like school complex (occupancy of 1500-2500 students) divided in two consecutive school cycles, the first to accommodate KG + Grades 1-5, and the second for Grades 6-12, allowing both genders to be in hosted in separated educational units but with shared common spaces.

The new school complex would have acted as a “Fourth Generation” of UAE’s public schools, meeting the contemporary pedagogical, typological, construction, and energy standards [9]. This future school was also intended to improve the educational experience of the students. In the Ministries’ thoughts, the new school model would have been replicated on the whole national territory, replacing about half of the existing public schools (about 300) that were considered unsuitable for the new technical and pedagogical demands. The administrative procedure of the competition was completed and awarded an entry. But it was never put into practice.

One of the possible reasons for the failure of the “School of the Future” is the fact that MOID and MOE, at the same time, were developing another concept: the so-called “Compact School”. This project aimed at converting schools into educational complexes with attractive learning environments that stimulate innovation. The schools would have more than one cycle and a much greater capacity than all current public schools. Moreover, Compact Schools would have both males and females in the same environment for the first time, while still respecting the segregation traditions of the country.
### Table 1. UAE public-school Models (plans drawn based on original plans from MOID).

| Generations   | Models          | Ground floor | First floor | Second Generation | Ground floor | First floor | Third Generation |
|---------------|-----------------|--------------|-------------|-------------------|--------------|-------------|------------------|
| First Generation | Khatib & Alami      | ![Image](image1.png) | ![Image](image2.png) | 586               | ![Image](image3.png) | ![Image](image4.png) | UPA1             |
|               | Qarawi           | ![Image](image5.png) | ![Image](image6.png) | 596               | ![Image](image7.png) | ![Image](image8.png) | UPA2             |
|               | Rais & Tawkan    | ![Image](image9.png) | ![Image](image10.png) | 740               | ![Image](image11.png) | ![Image](image12.png) | M-Engineering    |
|               |                  | ![Image](image13.png) | ![Image](image14.png) | 580               | ![Image](image15.png) | ![Image](image16.png) |                  |
|               |                  | ![Image](image17.png) | ![Image](image18.png) | 741               | ![Image](image19.png) | ![Image](image20.png) |                  |

The concept follows the idea of collecting students from the existing old facilities, resulting in their abandonment or demolition. The First school of this model is Zayed Educational Complex in Al Siouh area in Sharjah. Three other schools are under construction in two in Dubai and one in Ras Al Khaimah [9].

An entirely different approach was carried on with the “Upgrade of the UAE school sector”, which proposed the refurbishment of the existing school-building stock, to promote the preservation of a piece of the cultural history of the UAE, and also to extend the life cycle valuable resources (buildings embodied energy, time, land, and extra costs connected to demolition and new construction). The refurbishment of a sample existing school model (a “586” type, the most diffused model in the Second Generation; see table 1) was simulated to meet the requirements of the new UAE national curriculum, and to prove the benefit of this approach versus the construction of a brand new one. The architectural project to upgrade the sample school can be replicated on all similar types in the country, confirming the feasibility of the approach. However, each different model (table 1) would require a new design of the retrofit project. Furthermore, not all circumstances allow for the necessary construction enhancements. Nevertheless, the study estimates financial savings up to 30% if the approach was repeated on all country’s 586-model schools compared to the new construction proposal [8].
4. DISTRICT LEARNING: AN URBAN-SCALE APPROACH

4.1. Definition of the required entrepreneurial and industry-related pedagogical facilities
Today’s youth face significant challenges in picturing their future and choosing the right career. Different problems could create and increase the gap between school and university academic life, or even through industrial requirements. A way to ease this transition is to provide students, at early stage of their educational career, the required facilities that will prepare them for the market and offer them opportunities to gain work-relevant skills and knowledge. Career guidance facilities are the core solution to provide youth an immersive real-work experience. Moreover, as technology is nowadays shaping the work-environment, embedding new learning experiences within the UAE educational curriculum can be a great opportunity to also enhance the whole system. This new kind entrepreneurial and industry-related education (shown in Figure 1) can also help achieving the governmental goal of emphasizing knowledge-based economy [10].

4.2. Option 1: testing the application of the new facilities on sample existing school buildings
Once identified and sized the necessary new facilities, there is the need to investigate how these facilities can be efficiently implemented to verify the feasibility of the proposal. “586” and “Khatib and Alami” models (the most replicated models in UAE) have been chosen to test the upgrade strategy. After adding the new facilities to the existing school models in the form of simple masses (figure 1), many constraints were found making this solution inefficient:

- First, each school has a different plot size, which does not grant the possibility of adding a building extension in every case.
- Second, the different school typology, which requires the tailored design of the extension project.
- Third, the cost related to the design and construction of different custom facilities does not optimized the operation, making it potentially unfeasible.

Due to all these limitations, the option of providing the necessary learning facilities to each school pro-quota seemed inefficient.

The following section of the paper finally presents the alternative proposal ideated in this study, which implied to combine all new facilities together in a compact building that would be located centrally to multiple schools and serve them all, creating a new concept of educational neighborhood network named “District-Learning”.

Figure 1. Testing the application of the new learning facilities to two sample existing schools, the “586” model (top row) and the “Khatib and Alami” school model (bottom row). The different potential plot sizes affect the enlargements layouts and size (represented by the amount of the yellow block stacking).
4.3. Option 2: the District Learning approach

The UAE urban scenario is characterized by homogeneous functional clusters. School districts are frequently found, often in proximity to residential developments. This urban conditions fosters the strategy of a single central building to serve the whole educational neighborhood by adding a pedagogical offer to the existing surrounding schools, and expanding the horizon of their students to the community and the industry; hence university students will be help to tackle a better major in the university and be more capable in deciding their future career at an early stage; university students will acquire more industry-related skills, and be more prepared to enter the actual market. Moreover, this unique building could house laboratories (and other facilities for practical training) also for those conventional school subjects that need them: from the basic physics and chemistry to newer ones such as programming or robotics. Reduce the load of those spaces on the existing schools, would allow them having more space for extra classrooms. This strategy aims at increasing the number of students that the existing schools can currently host, as it is one of the objectives of the MOE (implemented in the “Compact School” project): not only would this strategy solve the problem of the existing schools’ capacity, but it would even invert the current trend seeing them slowly underloaded, then abandoned and demolished. Bottom line, this “District Learning” functions by means of a single new building that activates an educational network in symbiosis with the surrounding schools in the neighborhood, providing them with separated by near functions (needed to the school to be functionally and pedagogically upgraded), and implicitly retrofitting them (in a light manner, without operating significant changes on their infrastructure, yet preserving their functional, economical, and socio-cultural values).

4.4. Mapping, analysis, and classification of school districts

In order to check the application of the suggested approach within the existing urban fabric, a thorough survey/mapping campaign of all school districts in the UAE has been conducted (for synthesis, figure 2 only show the mapping Ajman, location of the site selected for the project). Each district was analyzed and then classified based on 5 factors (listed below). Each factor was assessed with a score. Finally, summing the scores of the different factors, the most suitable districts to test the proposal was identified.

1. The total number of schools within the district, which ranks each district as per the feasibility of building a new external facility for the district, awarding 1 point for 2-4 public schools, 2 points for 5-8, and 3 points for 9 or more.
2. School Model type, to verify how necessary the new building would be (the older the schools, the more need for new functions/facilities), assigning 1 point for the districts that consists of mostly 3rd generation public school models, 2 points for 2nd generation schools, and 3 points 1st generation schools.
3. School typologies to verify the feasibility of the approach, assigning 1 point for the districts with mostly 1st generation public school models (as these models require a heavy and expensive retrofit), 2 points for 3rd generation schools (because they already have a number of these laboratories), and 3 points for 2nd generation schools (the best-case scenario, as this models mostly require maintenance or a light retrofit).
4. Services in the neighborhood, ranking each district depending on the existing pedagogical-supportive services such as sport clubs, learning centers, and libraries. Districts that are highly facilitated with this kind of services are graded with 1 point, mid-facilitated districts 2 points, and districts with no services 3 points (as they are the more likely to need the new facility). The income level of residents or the area, estimated from the prevailing residential typology. 1 point for low-income districts, 2 points for medium-income, and 3 points for high-income.

4.5. Test-site selection and analysis

Based on the classified parameters, a final district assessment was conducted (table 2) to evaluate all the educational districts throughout the country. The school district of Al Jurf 2 in Ajman scored the highest and was selected as the most ideal area where to test the application of the proposed approach. Al Jurf 2 district consists of 8 public schools and 8 private schools, which by factor increases the demand for the
new building that will connect all of them together. The district is dense, with approximately 70% of its total built-up area covered by schools, and the rest with mix of mid- to high-rise residential buildings, commercial buildings (a few restaurants and cafes along the main street), and two governmental buildings (figure 3). An available plot for the construction of the new building is identified: the circulation analysis of the district is studied to assess the suitability of the selected position to connect with the surrounding schools (figure 3).

![Figure 2. mapping of the public and private schools in Dubai, Sharjah, and Ajman and identification of homogeneous school districts.](image)

**Table 2.** Final assessment of the school districts, based on the described grading system. Identification of the most suitable district to test the new upgrade strategy.

| Distance          | No. of schools | Model type (Functionality) | Model type (Feasibility) | Surounding services | Income of residents | Total score |
|-------------------|----------------|-----------------------------|---------------------------|---------------------|---------------------|-------------|
| Al Khalidiya (SHJ)| 1              | 2                           | 3                         | 1                   | 2                   | 9           |
| Al Qarayen (SHJ)  | 2              | 1                           | 2                         | 2                   | 3                   | 10          |
| Al Rashidiya (DXB)| 2              | 3                           | 1                         | 3                   | 2                   | 11          |
| Al Twar (DXB)     | 2              | 2                           | 3                         | 3                   | 3                   | 13          |
| Al Rams (RAK)     | 2              | 3                           | 1                         | 2                   | 3                   | 11          |
| Al Mamoura (RAK)  | 3              | 3                           | 1                         | 2                   | 3                   | 10          |
| **Al Jurf 2 (Ajman)** | **3**         | **2**                       | **2**                     | **3**               | **3**               | **14**      |
| Falaj mualla (UAQ)| 1              | 2                           | 3                         | 3                   | 1                   | 10          |
| Al Faseel (Fujairah)| 2             | 3                           | 1                         | 3                   | 3                   | 11          |

4.6. Design of the new educational building to serve school districts with different sizes and demands

The proposed building will help students grow innovative skills and be able to decide their future career at an early stage. The design permits flexibility in terms of the new required functions, and could also lower the load on existing schools with regards to certain subjects that requires practical learning, by shifting them to the new building where they would blend with other new functions. The proposed building’s functions have been classified into three categories: Core functions (reception, recreational area, and multipurpose room) on the ground level, more open and public to emphasize the connection with the surrounding; Flexible functions on the first floor (labs that can communicate with each other, like Business and Career development), which can open to each other and overlook the space below, but are separated from the public ground level; Non-flexible functions on the second floor (labs that require a fixed space, like Engineering and Technology). This layout develops linearly, so that the potential building can be sized according to the demand of any given schools’ district.
4.7. Concept Development

For the development of the site-specific building, the project site selection fell on the corner of the two main roads that lead to the school district of Al Jurf 2, to enhance the visibility of the building. As mentioned before, the public ground floor is designed to be completely open to the outside landscape, to enhance the connection of the building to the surrounding schools with the aim of engaging the community to its activity. As we raise, the functions become more rigid and private. The circulation inside the building avoids the use of conventional staircases and corridors, in the spirit of avoiding ‘closing’ the mind-perspective of the users (young minds). Instead, through parametric interior design, joinery and furniture become partition and ceilings (and vice versa), as well as the vertical and horizontal circulation. The rendering in figure 4 show exterior and interior views of the completed design.

Figure 3. Al Jurf 2 District analysis and identification of the available plot for the new building: connection to the surrounding schools and functions on the area, highlighting the educational vocation.

Figure 4. Exterior and interior renders of the educational building tailored for Al Jurf 2 area.

4.8. District energy assessment approach

The new building has been designed to meet the highest energy standards. Its energy performance has been calculated using the software Design Builder/Energy Plus (partial results in figure 5). The existing public schools, functionally affected by the presence of the new central facility, can also be mildly retrofitted: as said before, some labs previously located in the schools would now be shifted to the new facility, making room for new classrooms that would increase the capacity of the schools; while doing this alteration, certain energy improving operations can also be operated to the whole buildings. So, the proposed District Learning strategy, by involving the surrounding existing buildings, promotes its renovation and upgrade. The private schools, however, are considered not undergoing any alteration/retrofit (each with its ownership, it would be difficult to fully involve them in this operation). Furthermore, the study proposes a new way of evaluating the energy performance of the project at the urban level: the object of the assessment is not each individual building in the district (each school separately, and the new central education facility) but now a unique complex made of the distinct block.
This “district” energy assessment is a method that needs to be further investigated, keeping in mind that, nowadays, this strategy is not included in the National regulations and therefore its result is preliminary. The district energy diagnosis equalizes a heterogeneous building complex, or even an entire urban block, to a unitary element, made of different parts that are pro-quota responsible for the general district energy consumption. This concept derives from recent International design practices [11] and assessment rating experience (like US GBC, that has recently introduced a LEED for neighbourhoods). According to this principle, a building that with a low energy performance (the existing public schools, which undergo a partial energy retrofit, and the private schools that are not upgraded at all) will be averaged with others with higher-energy performance (in this case, the newly construction educational buildings, built to meet the current energy and environmental best practices). Figure 6 illustrates the district’s map with the different schools integrated in the functional-energy upgrade strategy actuated by the new central building: the public schools are retrofitted to a decent energy performance, while the private ones are indicated with a random average-to-poor performance (as they are not refurbished); both are averaged to the high performance of the new building in the hypothetical green building rating. This would not be possible in case of the “Compact Building” strategy, where the compact building itself would be very energy efficient but would not involve in the upgrade the existing schools, or the “Upgrade of the UAE school sector”, where not all public schools could receive the dedicated retrofit, and the energy improvement level would vary from case to case.
Figure 6. The District energy assessment strategy tested on the project site and surroundings.

5. Conclusion
This research addresses the “District-Learning” proposal as a feasible strategy to bridge the academic gap in the UAE’s educational system. It analyzes the different approaches and indicatives prior to it, then elaborates and tests a plan to develop the educational curriculum within a multi-school district that will strengthen the learning process in the community itself. Moreover, it supports the governmental initiatives and strategies to enhance the education system/sector.

The future stages of the research will focus on the three following aspects:

- Create a digital algorithm tool capable of cross-referencing all the achieved and collected data.
- Develop the construction project to support the concept of flexibility required by the project.
- Extend the district-learning guidelines to other districts in the UAE, to validate the procedure and elaborate outcomes that would assist the government in urban-level decision-making.

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