

# Education in the Digital Transformation Era. The Common Mistake: One Size Fits All

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**Abstract** Disruptive technologies have changed the working, business and financial models of many sectors and aspects of life. Education and learning were among the top sectors influenced by digital transformation, and the stay-home era forced by the spread of COVID-19 accelerated the change. Many educational institutions (schools and universities) moved to online classes and learning material was made available over the internet. The two pandemic years served as a good experiment to show the advantages and disadvantages of such new learning models. On the return to normality, many recognized that smart campuses are a must, and the trend is accelerating.

In this chapter we examine the new educational model that is being adopted. It can easily be seen that there is no single model that will fit all categories. For example, what would work for a university would not necessarily work for secondary schools, and what would work for secondary schools would not necessarily work for primary schools. In fact, the situation is even more complex. Geography, culture, social status and family ties also need to be considered. Here we examine different scenarios and give recommendations on how to approach each case. Assumptions based on observations from different Egyptian cases will be presented.

**Keywords** Digital transformation · Smart campus · Learning technologies · Geographic and social impact · Education infrastructure

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## 1 Introduction

Today, the education landscape is facing multifaceted disruption due to the new characteristics of the digital student. The COVID-19 pandemic accelerated the transformation of educational institutions into providers that are more dependent on information and communications technology (ICT). Generation Z students are demanding a more-personalized education, just like they find on the web. They are dealing with the education process exactly like consumers getting a service or product on the web.

In order comply with this generation's demands, educational institutions need to have new tools to deliver the service to them. The smart campus concept will enable those institutions to deliver in the way that students prefer.

There is no single definition for the expression: “**Smart Campus**”. In addition, there is no consensus on the components of smart campuses in universities or schools. The main concept of the smart campus is establishing a way for direct communication between the educational institution's management and the students to enable a better educational process.

From the previous point of view, a smart campus can be the campus that uses networked technologies to facilitate communication, enhance security, use resources more efficiently, and of course, save money.

Deloitte [1] defines smart campuses as the campuses that are designed to improve student experience, increase operational efficiency, and enhance education through a well-architected infrastructure.

A smart campus can be considered an educational institution that leverages innovative smart technology to create better educational experiences and outcomes for its students, staff, and institution.

In this chapter we present the idea of a smart campus and then pose some questions about the validity of such a model for different needs (geographical, sectorial, and social). Section 2 introduces the motivation and justification for moving towards a smart-campus enterprise architecture. Sections 3 and 4 describe the idealistic structure of a smart campus, followed in section 5 by the risks associated with smart campuses. Sections 6 and 7 discuss the challenges of the one-size-fits-all option, starting with the base challenge of digital transformation (section 6) followed by the sectorial and social challenges (section 7). In section 8, we make some recommendations to overcome the challenges before drawing our conclusions (section 9).

## 2 Why do Educational Institutions Need Smart-Campus Systems?

Educational institutions are facing several challenges in delivering their services to students, so they need digital systems to enhance the process of managing the educational services in addition to providing better administrative services to students. The following are the important objectives educational institutes are aiming to achieve through the use of smart-campus systems:

- **Better resource utilization:** by using networked smart lighting to reduce use and conserve energy, a campus can save on resources.
- **Enhancing student experiences:** by using smart devices, a campus can easily provide wayfinding to new students and visitors on campus. They could also improve the quality of life by fostering a healthier lifestyle with wearable monitors. Moreover, the massive amounts of data that can be taken from employing Wi-Fi, hotspots, and voice-enabled devices can be used to streamline the student journey.
- **Better facilities management:** by using Wi-Fi access points and analyzing when students and staff enter and leave a certain area, educational institutions can automate temperature control and other settings in facilities by utilizing machine learning and advanced Internet of Things (IoT) applications.
- **Enhancing the patterns of internal movement:** by monitoring movement patterns within the campus, the institute can design systems with optimized routes to facilitate movement during peak hours, so the educational institution can, for example, tell the students and visitors what parking is available.
- **Transportation schedules:** an educational institution can easily ease the burden of finding parking with new campus technology. By using cameras, sensors, and Wi-Fi, students can find a parking space without constantly circling the campus to find one.

In addition to the above-mentioned objectives, educational institutions need smart campuses systems to:

- Monitor flows of people with the possibility of not only opening/closing pathways to hotspots on campus, but also lighting corridors and halls.
- Facilitate the traffic flow by finding and indicating the direction of travel to a location on campus (buildings, classrooms, library, publishing house, dining hall etc.).
- Facilitate prevention of accidents and disasters through constant monitoring of noise, temperature, humidity, smoke, and light in the halls of the institution.
- Implement various statistical analyses and take measures to increase the quality of education in terms of environmental and safety conditions.
- Reduce water and electricity consumption.
- Efficiently stock-take the inventory of equipment and other assets.
- Create a conducive environment to increase socialization among all members of the educational institute's community.
- Use the accumulated data to achieve various useful applications.
- Eliminate systems breakdowns caused by hacker attacks or technical problems that can lead to substantial data leaks and losses.

### 3 How Do Smart-Campus Systems Work?

By using technology, smart campuses allow students and the institution's staff to accomplish tasks more efficiently and enjoy new experiences. Achieving such results needs the use of new solutions, such as cloud-based portals to access class timetables and resources, the digital signage that helps students reach their classes, or integrated tools that help professors, teachers, and instructors to better connect with students.

Smart campuses help educational institutions to enhance the following areas:

#### **a) Managing the admissions**

Uploading enrollment applications to universities or schools offline is a lengthy and tiring process. On the other hand, submitting them via a unified digital education system is much more efficient.

#### **b) Minimizing risks**

Whether a student is sick, or the classes are canceled due to severe weather conditions, online learning can handle it all. Now, to maintain excellent attendance rates and not miss an important lesson, students can simply click on the "**Join**" button of the meeting tool or just read through the material uploaded onto the cloud.

#### **c) Improving learning outcomes**

With interactive lessons and by implementing high-tech solutions, the institution can motivate students to improve their learning skills.

#### **d) Evaluating performance**

The process of digital transformation in education offers many benefits for students, such as faster access to tests and grades through online systems. Online learning systems allow submission of a paper, plagiarism checks, and tracking attendance. All of these factors, which contribute to a student's' performance level, can be easily measured by the institution via the digital platform.

The implementation of the above-mentioned areas can have direct benefits for the educational institutions. These benefits can include the following:

- Improving the student experience and increasing student retention.
- Boosting operational efficiency.
- Automating workflows and processes.
- Conserving energy and resources.
- Reducing human error by automating population data.
- Deriving insights using data analytics.
- Fostering better interaction within the university environment.
- Leveraging interactive learning models.
- Creating a standard of continual technological improvement.

## 4 Technologies Used in a Smart Campus

Due to the evolvment of digital innovations in the education sector, an implementation pattern for systems in many educational institutions has been devised. We will discuss the most popular technologies in the following points.

### a) Enhanced accessibility through online classes

Distant learning has become a huge trend and allows learning materials to be more accessible to many students than the on-site format. Nowadays, students can attend any college or school worldwide while remaining in their own room. In addition, they have more opportunities to enjoy the same level of education as their peers regardless of any disabilities or health issues. They can use Voice-over for texts and many other accessibility features that are becoming increasingly widespread, giving everyone equal opportunities to study. Online meeting tools like Zoom or Google Meet enable millions of learners to obtain the education they want, even though they don't have sufficient funds or the ability to travel.

### b) Smart classrooms

Offline learning has also improved since the use of smart boards, projectors, access to the internet, and computers has become common, allowing students to quickly get necessary information and search for extra materials in real-time.

### c) Customization of the learning process

Depending on how a student comprehends information the best, it's now possible to create personalized study plans and frameworks to ensure the most effective learning regime. A student has the freedom to choose a preferred lesson type as well as interact with new information in the most convenient way.

### d) Virtual reality and augmented reality

Adding virtual reality (VR) and/or augmented reality (AR) elements to the educational process will not just increase interaction and promote greater student attention, VR and AR will also allow learners to feel all the bonuses of on-site education from home. Virtual field trips, simulators for completing practical tasks, and obtaining skills instead of reading about them are some of the main advantages of integrating VR technologies into the learning process. Moreover, AR will let the students feel that they are using real objects, just as if they are living with those objects in real life.

#### **d) Cloud-based services**

Storing all educational materials on a cloud ensures instant access for any student worldwide. This technology allows remote students to submit assignments online, receive home tasks quickly, and access streamed lectures and webinars. In addition, cloud-based platforms will enable students to seamlessly collaborate on group tasks from home and even take their exams remotely.

#### **e) Internet of Things**

The IoT is bringing many changes to the learning process. Educational institutions are creating smart campuses, automating many repetitive tasks, and giving everyone access to high-tech tools that facilitate the student's life.

The IoT-based modules that can be used in educational institutions include:

- *Smart parking*: monitoring the university's parking facilities and finding the number of vacant spaces, enabling staff/students to avoid traffic jams or accidents.
- *Smart lighting*: automatically adjusting the classroom light based on the data sent by an external sensor monitoring the natural light level, which will reduce electricity consumption.
- *Smart tracking*: use of radio frequency identification (RFID) technology to monitor students inside the campus and allow their quick evacuation in emergencies; both goods and equipment can be monitored.
- *Smart inventory*: each piece of equipment or component (CPU, monitor, mouse, printer, scanner, copier etc.) can have an associated bar code, which represents an inventory number, and a QR tag. By using a device connected to the internet with a barcode reader this equipment can be identified and all associated information (technical specifications, administrator, funding source etc.) can be displayed.

#### **g) Big data and analytics**

Big data technology can be the perfect solution for managing vast piles of information, its organization, and analysis. In education, big data can help track student performance and find ways of improving the learning experience. In addition, collecting grades, exam results, and other data in a unified online system allows teachers to quickly evaluate their performance, track attendance and study plan progress, evaluate papers faster and see what subjects or topics need improvement.

#### **h) Blockchain**

Blockchain technology can be used to store the personal data of staff and students. In addition, using blockchain technologies helps maintain security which is the main prerequisite for implementing it. Also, it allows authenticity checks that reduce plagiarism and cheating.

#### **i) Artificial intelligence**

Artificial intelligence (AI) has the potential to address many challenges in education as well as bringing innovation to teaching and learning practices. Artificial intelligence can help in creating custom study plans, evaluating the approximate student grade point average (GPA), improving student performance, and enabling more accessibility options. Moreover, AI can increase staff effectiveness and help them deliver a better educational experience. Chatbots, FAQs, and process automation can be great examples of how AI works in the education sector. Having said that, we need to ensure that applying AI technologies must be guided by the principles of inclusion and equality.

## 5 Smart-Campus Risks

Educational institutes are aiming to create smart campuses that promote connectivity, health and wellness, and sustainability for their students. This means providing a more holistic and connected student experience. The benefits of these changes merit discussion around strategies such as high-speed data infrastructure; pervasive Wi-Fi; IoT sensors for monitoring environments; enhanced digital services for students; classroom technology to support hybrid learning; smarter transportation; and greater data insights.

New technologies and innovations can be accompanied by risks, and we need to mitigate these risks and learn lessons from each other. The following presents some of the risk considerations educational smart campuses may face.

### a) The risks due to complexity

Because of the complexity of the co-operating systems in smart campuses, there is a great need for operational and information-technology services to exchange data. If a student utilizes a single ID badge to access a building, pay for food in the café, and reserve a group-study room with a simple badge tap or swipe, this involves multiple cyber and physical systems that potentially need to exchange data. Implementing such a process correctly, would be very convenient for the student and reduce delays when travelling around the campus. However, some risk factors present themselves in this case and we should take these into consideration. Those risk factors can be as follows:

- Has the sequence of operations been properly taken into consideration?
- Are the divisions of responsibility among the different vendors clearly articulated?
- Are the systems being specified interoperable so that the intended data can be exchanged?
- Who provides system commissioning, service, and support for an interconnected set of systems?
- Who owns the issue when the integrated functions fail to operate?

There are literally thousands of examples of these connectivity issues occurring with both new and legacy campus systems. Simply put, the higher the degree of complexity in your smart campus, the greater the likelihood of problems cropping up. That's why it's essential that the system complexity versus end-user convenience benefit calculation is done early to determine if the net result is worth the costs and effort to pursue.

### b) Student data security and privacy

With technology quickly becoming such a critical feature in the daily lives of students and teachers, security has become another necessary consideration in the digital-education revolution. Educational institutes are collecting a wealth of information on students, from their personal data to grades etc. When students are moving through a smart campus, their data are exposed to various systems and services, for example, they may be using mobile apps to navigate around campus via wayfinding tools, checking transportation schedules from the local bus route, ordering food to be delivered to their preferred place of study, and tapping into news and events. Although these apps may create more convenience, they may also open the door for exposing the students' data to others without the knowledge of the institute. Some risks that should be considered:

- Where are the data from the app hosted? Is the host secure and does it meet data privacy policies and best practices?

- Do students have the ability to disable location services within the student app?
- Is the app platform sharing any student data with third-party vendors it connects to?
- Is the app using end-to-end encryption for messaging?

## 6 Challenges Facing the Digital Transformation in Education

Digital transformation in education is facing many challenges especially in developing countries. Those challenges are limiting the ability of the educational institutions to benefit from most of the above-mentioned technologies. Some of the main challenges the educational institutions are facing in our region are as follows:

### a) Lack of robust infrastructure

Educational institutes need robust, fast, and high-quality connectivity to be able to implement digital transformation within the organization. In addition to the high-quality GSM (global system for mobile communications) connectivity that enables students to use their mobiles to access information through the available apps, fiber connectivity to the last mile within the campus is essential. In our region, we may have a wide digital gap between different cities in addition to the financial-capabilities gap between the private educational institutions and the public ones.

### b) Lack of a technology-enabling environment

As we discussed earlier in the chapter, the systems used in smart campuses need cloud-hosting for their content, IoT applications to control the different systems within the campus, blockchain applications, big data and data-analytics systems, AI systems, etc., but not all such systems are available from local vendors, or they are not even aligned to match every country's student culture. In addition, all those systems need to be acquired or even used as a service, but not all of them are affordable to the institutions. Moreover, using those applications needs a huge IT staff within the educational institute and not all the educational institutes can afford the associated cost.

### c) Lack of up-to-date IT systems

Not all educational institutions have sufficient technology stacks to transform the delivery of their services. This means that they may not have computers or Wi-Fi access, and others may have outdated e-learning portals.

### d) Lack of digital transformation strategies

Many educational institutions do not engage in developing digital transformation strategies. In addition, they either may not have the time or don't know how to incorporate a particular technology into the educational process. In such cases, strategies must be the mandate of the educational councils of the country. Should there be a clear national digital transformation strategy, then the educational institutes can have guidelines to implement the nationally predetermined plans.

### e) Lack of up-to-date systems

Many educational institutions have an insufficient technology stack to transform their learning system. As an example, some schools and universities may not have sufficient computers or Wi-Fi access, and some have outdated online portals or learning managements systems. That is why it is essential to update the technologies and the learning system first to achieve the necessary digital transformation in educational institutions.

#### **f) System breakdowns**

System glitches or breakdowns can happen due to hacker attacks or technical problems (e.g., with servers). This may lead to substantial data leaks and losses, which are unacceptable for a reputable institution. The lack of technical expertise and knowledge of cybersecurity basics are the key factors that can affect the e-learning system.

#### **g) The economic and cultural gap**

Not all the students in higher education (or even schools) can afford to have the required devices to interact with the facilities provided by the smart campuses. This may be due to economic reasons, especially for the students with backgrounds that are lower middle class or less. In addition, those students may also have cultural barriers to dealing with the sophisticated devices needed for such access. They may also be unable to afford the cost of connectivity. Generally, the gap is wider in rural areas than in urban areas, so the students from rural areas may face more difficulties in dealing with smart-campus systems than their peers from urban areas.

## **7 Dealing with the One-Size-Fits-All Problem**

In this chapter we have examined the new educational model that is being adopted. It can easily be seen that there is no single model that will fit all categories. The above components of the smart campus cannot all be present everywhere. The immediate explanation will be “of course this is due to budget limitations”. But the truth is that, even if the budget is sufficient, some of these components and models will suit neither the recipients of the service (the students) nor the providers of the service (the teachers). What would work for a university would not necessarily work for secondary schools, and what would work for secondary schools would not necessarily work for primary schools. In fact, the situation is even more complex. What works for arts, law and business faculties does not work for practical lab-work-based faculties (engineering, medicine and pharmacy), and to further complicate matters, what works for engineering does not work for medicine, etc.

The above is just the first two layers of a very complex model, namely, the age and the field of study. Three more issues play a role in defining a suitable model: culture, social status and family ties.

To illustrate, for a country like Egypt, geography plays an important role. Cities can adopt a model that will not work for villages and even the culture in Northern Egypt is quite different from that in Southern Egypt.

We could also think of society in terms of five economic categories: very poor, poor, lower middle class, upper middle class and comfortable. For each class, the tools available and the access to technology differ and hence the opportunity to learn is radically different.

Last but not least, we must acknowledge the fact that for school children the role of the home is of prime importance. It must, therefore, be clear that models that suit a closely tied family may not be suitable for divorced parents where the children live with grandparents or a single parent.

Thus, we need to identify all the interactions among the following categories:

#### **Category 1. University field of study**

1. Science-based faculties (includes medical, pharmaceutical, nursing, agriculture, basic science, etc.)
2. Engineering-based faculties (includes engineering, architecture, computer science, etc.)
3. Business- and literature-based faculties (includes economics, accounting, political science, law, arts, etc.).



4. Arts-based faculties (includes media, mass communication, theatre, movie production, etc.)

### **Category 2. Age of School Students**

1. High schools
2. Middle (junior high) schools
3. Elementary schools
4. Kindergarten schools

### **Category 3. Urban vs. suburban**

1. Cities
2. Suburban
3. Villages

### **Category 4. Habits and culture**

1. Large Cities (Cairo Alexandria, etc.)
2. Northern Egypt
3. Southern (Upper) Egypt
4. Deserted and remote areas

### **Category 5. Social status**

1. Very poor
2. Poor
3. Lower middle class
4. Upper middle class
5. Comfortable  
Rich (will be excluded from the model)

### **Category 6. Family status (couples vs. single parents)**

1. Married couple
2. Divorced couple, children living with their father
3. Divorced couple, children living with father and stepmother
4. Divorced couple, children living with their mother
5. Divorced couple, children living with mother and stepfather
6. Widower/single father
7. Widow/single mother

### **Category 7. Student status**

1. Normal
2. Handicapped
3. Slow learner (including autism, etc.)
4. Super learner

Clearly, category one (university) is the easiest to provide for because we can devise a model for each of the subcategories that matches the type of study.

However, it becomes really complicated for categories 2 to 5 because we must consider all the intersections of the subcategories to build a specific model. For example, the model for an elementary school (2.3) in a poor (5.2) village (3.3) in upper Egypt (4.3) will be radically different from that for a secondary school (2.1) in an upper middle-class district (5.4) in Cairo (4.1).

Categories 6 and 7 are dealt with through the service providers (teachers) and some subcategories will need special tools to be available. True, the disruptive technologies are providing lots of helpful aids but, even so, the normal model needs to be modified.

## **8 Overcoming the Digital Transformation Challenges in Education**

To overcome the challenges, we presented earlier in this paper, we need to take the necessary actions to:

- Enhance the telecom infrastructure to enable educational institutes to use ICT-based educational solutions in a smooth way.
- Encourage the educational councils to develop a digital educational strategy to assist institutions implementing the transformation.
- Encourage investment by creating a nation-wide technology-enabling environment that can be used to provide the different types of services needed by the educational institutions.
- Encourage local development of the software systems and applications needed for the digital transformation of education to squeeze the cost and to guarantee their suitability for the local culture and community.
- Use the best-practice models to create funding mechanisms to finance the digital transformation process for educational institutes.

## **9 Conclusion**

Creating smart campuses and implementing digital transformation requires a spirit of innovation, stakeholder engagement, partnership, and a fundamental shift in how we think about students' experiences on and off campus.

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