Smart Learning Environment for Engineering Faculty: TIU as a Case Study

Rand B. Mohammed[1] & Merve Sumeyye Taha[2] & Sana Basil Mohammed[3]

[1]Mechatronics Engineering Department, Faculty of Engineering, Tishk International University, Erbil, Iraq
[2,3]Interior Design Department, Faculty of Engineering, Tishk International University, Erbil, Iraq
Correspondence: Rand B. Mohammed, Tishk International University, Erbil, Iraq.
Email: rand.basil@tiu.edu.iq

Doi: 10.23918/eajse.v8i1p187

Abstract: This paper examines Smart Learning Environments (SLE) as a novel educational strategy for comprehending the impact and potential applications of technologies in the classroom. This article aims to clarify the theoretical approach to SLE and develop a novel model based on it. This research paper focused on the analysis of the existing learning spaces at Tishk International University that is used by the students of Engineering Faculty. The research proposed a modification on the learning spaces to be smart learning environment. The applied modifications will be in two main aspects, first aspect by redesign the learning spaces according to the standard to guarantee the most interactions between the instructor and the students, the second aspect by implementing a smart system at each learning space to ensure safety, security and provide a comfortable environment to the students during their time at the lesson.

Keywords: Smart System, Learning Environment, Redesign Space, Engineering Faculty

1. Introduction

Human experiences, cognitive awareness, personal biases, beliefs, cultural history, and environment all influence the process of learning. A person's knowledge and skills improve gradually and persistently through time; this is the definition of learning. Individuals learn because of their interactions, which involve the transfer of knowledge and abilities from others and via experiences. Thus, learning is a unique experience that allows a person to expand their knowledge, perspective, skills, and comprehension. Consequently, individualized learning models can assist in matching the requirements and aspirations of individuals. In addition, the incorporation of technology can be crucial for personalizing the learning experience (Shemshack, 2020).

The learning environment comprises the physical locations, circumstances, and cultures from which students acquire knowledge. It is also a complicated and dynamic system in which teachers adopt specific tactics and employ available resources to achieve predetermined learning objectives. The learning environment is crucial to the learning process since it aids in the development of the learner's abilities, knowledge, attitude, and behaviour. Even while the term learning environment has traditionally been used as a synonym for a physical classroom, it has been modified to include more effective and efficient digital tools, approaches, and strategies (Çeken, 2022).

Received: March 18, 2022
Accepted: May 26, 2022
Mohammed, R.B., Taha, M.S., & Mohammed, S.B. (2022). Smart Learning Environment for Engineering Faculty: TIU as a Case Study. *Eurasian Journal of Science and Engineering*, *8*(1), 187-202.

Effective teaching and learning are necessary for students to acquire the knowledge and skills essential for their future careers. Many aspects contribute to learning effectiveness, and the learning environment is one of the essential ones. Learning results can be affected by the learning environment (Fraser, 1981). The learning environment is the location designated for learning to occur. According to Wong (1998), the learning environment is the social, psychological, and pedagogical conditions in which the learning process occurs and might influence students' achievement and attitudes. A suitable learning environment can stimulate intellectual activity and foster friendship, cooperation, and support while facilitating learning, student growth, and development.

Additionally, the learning environment might affect student conduct and social interaction. Consequently, the learning environment must be well-managed so that students can study comfortably, actively collect helpful information, get relevant experience, evaluate their learning, and provide feedback on their individual experiences in various social contexts.

Incorporating technology into the learning process is typically referred to as technology-enhanced learning or smart learning environment (Çeken, 2022). Common definitions of smart learning environments focus on the tools (and, occasionally, the techniques) that are found within them or of which they are constituted (Dron, 2018), by mixing the learning objects with smart and mobile technologies to facilitate active learning experiences through smart learning processes (Gambo, 2021) to increase student engagement, teaching and learning, and evaluation in both natural and virtual classroom settings (Vijayabaskar, 2020). In comparison to traditional learning environments, smart learning environments facilitate just-in-time learning by providing learners with varying degrees of adaptation and precision of diverse learning conditions. In smart classrooms, new teaching methods such as cyber synchronous learning, mobile learning, etc. are utilized. These instructional strategies are unavailable in conventional classrooms (Cheung, 2020a).

Smart learning environment produces novel approaches to intelligent learning, technology services for local on-campus and online students, easy local and remote student-to-faculty contacts, and local and remote student-to-student partnerships. The advent of a smart learning environment as a rapidly expanding field reflects the interconnected nature of learning objects, learning processes, and learning activities, which can facilitate individualized and inclusive learning experiences. Using smart and mobile technologies, it is possible to create a smart learning environment that is personalized to fit the demands and learning styles of learners. It offers a student-centered learning environment that blends multiple pedagogical methods and tactics to practice and reflect on the learning process; and includes formal and informal learning situations (Gambo, 2021).

2. Literature Review

Globalization has had a major influence on every aspect of the planet involving human beings. Globalization has disproportionately impacted various areas, including education, transportation, finance, health, and insurance. The internet, which encouraged globalization, is a worldwide network available to everybody (Martin, 2013). The internet has recently gained prominence as a tool for high school pupils wanting to improve their academic performance.

Generally, educational institutes are classified into two types: traditional and smart educational institutes. For conventional educational institutions, such as direct instruction, difficult literature, and library use, the internet's inception and development have resulted in a drastic reduction (Yang, 2018).

Students benefit from the internet since it is far less expensive than recommending them (Watters, 2013).

Smart learning environments have been produced via the integration of information technology with the educational process to promote student engagement, teaching and learning, and evaluation in both natural and virtual classroom settings. Changes in classroom environments and teaching techniques brought about by the advent of information and communication technology are commonly emphasized as a means of improving educational outcomes (Vijayabaskar, 2020).

A smart classroom is a form of technology-enhanced teaching environment that is gaining global appeal. Cebrián (2020) defines the smart classrooms as educational spaces that incorporate technology in a variety of ways, ranging from the incorporation of digital devices and learning software to the inclusion of sensor networks that aid in monitoring classroom processes, collecting information, and offers insight to aid in decision making for more effective and expedient learning (Cebrián, 2020).

Çeken (2022) defined different concepts of technology-enhanced learning such as mobile learning, computer-based learning, web-based learning, augmented reality-based learning, and virtual reality-based learning are all examples of several types of education. Numerous modern technologies, including mobile devices, Web 2.0, augmented reality (AR), and virtual reality (VR), have been progressively exploited in the learning process to improve the learning process by utilizing their unique qualities. AR and VR have been utilized in 96% of UK universities and 79%t of UK colleges to give students with high-quality experiential learning.

According to Cheung (b) (2020), smart learning refers to learning in interactive, intelligent, and personalized learning environments that are based on modern technologies and services, such as augmented reality, cloud computing, and social network services. Yue (2008) defined the smart learning by enabling the students to learn through the use of computer hardware, software, and other forms of multimedia. Based on Yue opinion the smart classrooms are one of the simplest resource conversion approaches that can be used to change older educational institutions into more modern ones via the use of new technology. Students must be zealous in their pursuit of knowledge. Students cannot expect to obtain the required achievements without this interest. As a result, smart classrooms facilitate the cultivation of this drive for academic performance. Smart boards, tabs, laptops, projectors, and multi-screens are all part of the equipment in a smart classroom.

Smart classrooms differ from traditional classrooms in that they use cutting-edge technology, whilst traditional classrooms continue to rely on more traditional methods of teaching and learning (Yue, 2008). Smart classrooms are extremely unique from traditional classrooms, and it would be a mistake to see them as technologically upgraded versions of traditional classrooms. The conventional classroom's learning environment was confined by its physical dimensions, learning materials were accessible in the form of hard copies such as books, and teachers' pedagogical styles were based on these fixed resources with contextual constraints. The incorporation of technology into the learning environment involves adjustments to instructors' and students' pedagogical approaches to teaching and learning, the role of learning materials and sources, classroom management, and education and resource management. A smart classroom has various advantages over a traditional classroom, including the development of children's technical abilities and ability to communicate with the outside world (Yue, 2008).

Bautista (2013) defined three interacting axes in the design and usage of learning spaces: classroom layout and ergonomic structure, technology integration, and appropriate pedagogical methodology. These three components, physical layout and structure, technological integration, and pedagogical methodology, must be compatible and adaptive in order to interact synergistically to generate classroom outcomes (Bautista, 2013).

3. Methodology

There is no one type of approach to creating a smart classroom. There are several innovative learning spaces located throughout the world in a variety of educational institutions that, due to their uniqueness and structure, can be considered smart classrooms or labs. Smart Learning Environment in this work will focus on two aspects: first rearrange the study halls at TIU (TISHK International University) for Engineering Faculty to means the international standards based on the suggestion of WHO, the second one is implementing a smart system at each hall to provide safety, security and provide a comfortable environment to the staff and students.

In this work the learning spaces were divided into three parts, classroom, design studio, and laboratory. The physical layout and the technology were integrated at each of them to meet the objectives of this work.

Seven main elements were considered to meet the suitable design for smart learning environments.

1. Flexibility and Physical Arrangement, means the seating arrangement at the learning space to ensure connection between student and instructor as well as ensure a comfort seating for the students. At TIU we are focusing on three different types of learning spaces, which are lecturing halls, laboratories, and design studio (Mohammed, 2021). The class halls are going to be fixed and arranged in a way that can guaranteed a connection between the instructor and students as well as a comfort way of seating, while the lab can be arranged in a way that suits the type of the practical sessions in addition to the instructors, lab assistants and students.
2. Comfort: A smart classroom should be set up in such a way that students may comfortably engage in a variety of activities — between students and instructors or between students themselves, this including the suitable class environments, such as controlling the light inside the class as well as the curtains, based on the day time, in addition to control the AC according to the class temperature and choose the suitable mode accordingly, as well as ensure a good ventilation system provide inside the class, especially with the Covid time, to ensure providing a healthy atmosphere to the people inside the class.
3. Multiplicity: This principle refers to smart classrooms that are outfitted with qualities that allow the usage of a variety of resources and stimuli. While teaching and learning, the environment should foster possibilities for creativity, reasoning, and logical thought and be as adaptive as possible to students' various needs and learning styles. Therefore, it should be an atmosphere where we may freely access any physical or digital source of information.
4. Connectivity: To leverage the potential of mobile devices, the learning environment must feature solid local and global network connectivity. Wireless connectivity is essential for maximizing environmental mobility and user comfort when utilizing technology.
5. Personalization: Smart classrooms should enable students and teachers to customize their learning environment to their preferences and needs. Thus, we are not referring to a uniform, impersonal, or frigid atmosphere but to a space that teachers and students should gradually personalize through activities that encourage and reinforce learning.

6. Order / Organization: This is a critical idea, even though designing and implementing sustainable placement, storage, arrangement, and usage norms for given areas and resources is not straightforward. As a result, we designed and organized the layout of the spaces including the lecturing halls, laboratories, and design studio in a way that help ensure that they are optimal for the learning activities that will take place in their smart classroom.
7. Safety / Security: Learning spaces that are heavily technologically integrated demand a high level of security in both hardware and software. Smart classrooms will be designed so that users are protected from physical harm and have secure access to information and communication via the Internet from the classroom. To ensure safety inside the learning spaces a fire alarm system has been implemented which can detect Gas, Smoke and Fire and give alarm, also each space has an emergency exit door to ensure evacuating in the class in case of emergency. Health safety has been seriously considered as a main issue when design the halls, starting from checking the body temperature for the students before allowing them to enter the class, and the main door is only going to open for those students who are already registered join the lesson, because at the entrance of the learning space the student need to scan their ID, only the registered students are allowed to enter the class.

4. Design

The smart learning environment has been designed and implemented at the Engineering Faculty at Tishk International University, several studies and steps were passed until we reached this design. First a site study was made to check the existed design for the classrooms, then a questioner was applied to the students and staff to see their requirements, and the final stage was about checked the existed design from other researchers, then a combination of all of these criteria taken to get the proposed design.

As mentioned previously, the engineering faculty had taken a case study to develop the learning environment, with the all various departments we can divide the learning spaces into three types, first is the teaching halls where the theoretical lesson given and the exams conducted, this include seating areas arranged as rows and columns, as shown in Fig. (1). The second type of the learning space is the design studio which is mainly used by the department of Architecture and Interior Design and used for the practical design lessons, the 2D plan for the design studio is shown in Fig. (2), while the third learning space is the laboratory that used by most of the department for their practical lessons such as Computer Lab, Electronics Lab, Robotics lab and so on; the 2D plan is shown Fig. (3).

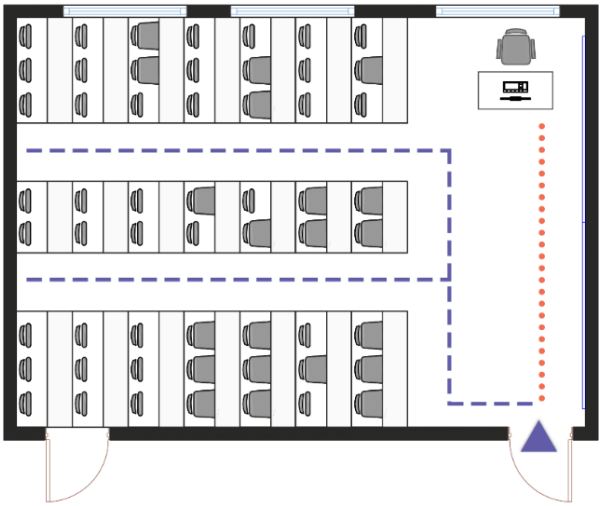

Figure 1: 2D plan for the existed study hall

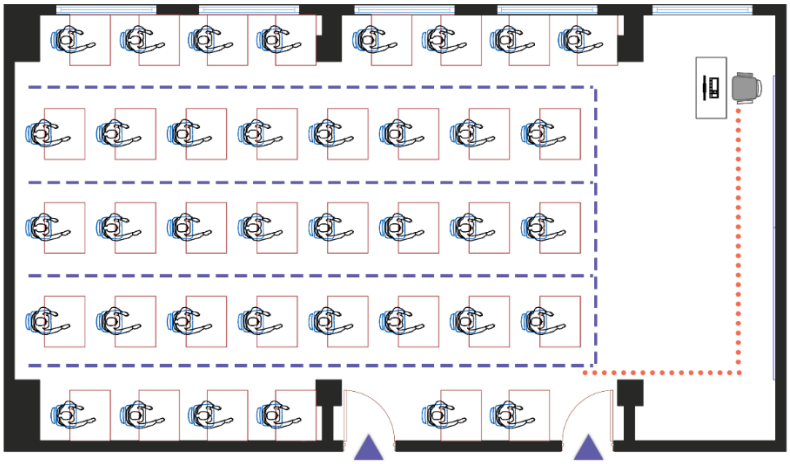

Figure 2: 2D plan for the existed drawing hall (design studio)

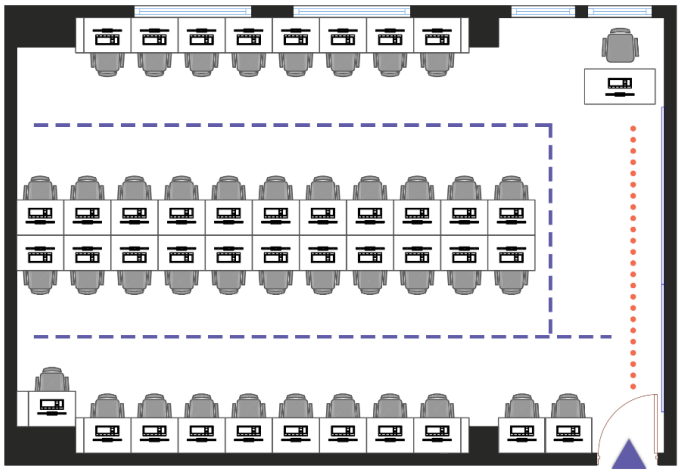

Figure 3: 2D plan for the existed laboratory.

Redesigning the existed halls will focused on two aspects: first re-design the halls to meet the need of modern teaching methods as well as the health instruction that have become the common concern in the last two years because of the Covid and similar issues, this will be done based on the perspective of the Interior Designer, and the second one will focus on adapting these classrooms with technology to be smart classes by covering all the possibilities to guaranteed safety and security as well as supporting the nowadays requirements, from the view of Electronic Engineer.

4.1 Re-design the Learning Spaces

At TIU, the most common learning environments are conventional classrooms. They have fixed furniture for the student seating area and a movable desk and chair for the instructor. As an example that shown in Fig. (1) the classroom includes 56 places for students, with one traditional whiteboard and one interactive board.

To redesign the classroom, we considered the standards by reducing the number of seating areas from 56 to 42 in the plan arrangement. By creating a space between the door and the sitting area, we made the second door in the classroom usable when needed; the plan layout and the isometric of the classroom are shown in Fig. (4) and Fig. (5) respectively. In addition, we have added a portable divider to the tables to prevent the possible virus from spreading easily as shown in Fig. (4).

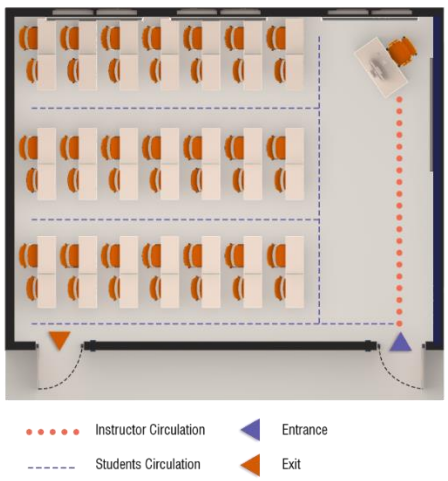

Figure 4: Modified classroom plan layout. Figure 5: Isometric for the redesigned classroom.

The second types of learning space at the engineering faculty of TIU are the design studio hall, where the practical lessons for the design course are conducted, the students of each grade spend around 10-12 hours weekly at the design hall, therefore, it is important to consider improving the environment for the interior space.

Designing the interior space of the design studio hall is divided into two parts, the first part is related to the instructor with a chair and desk, while the second part is related to the students with a capacity of up to 38 students. The existing design studio hall has a smart board and white board, with a natural light through the windows, and good ventilation. For the movement inside the hall, because of the number of drawing boards that could reach 38, which can be considered big compared with the size of

the hall, which can cause a difficulty in circulation; the 2D plan for the existing design studio hall is shown in Fig. (2).

Redesigning the design studio hall will focus on reducing the number of boards, according to the standard, to expand the area of movement and provide easier circulation. Figs. (6-7) show the plan layout and the isometric for the redesigned studio. Display boards will be distributed over the studio's wall which allows us to save area during the submission time by using them to display students' work. The second door location will be changed to be more useable especially in some circumstances such as evacuating the hall in any emergency case.

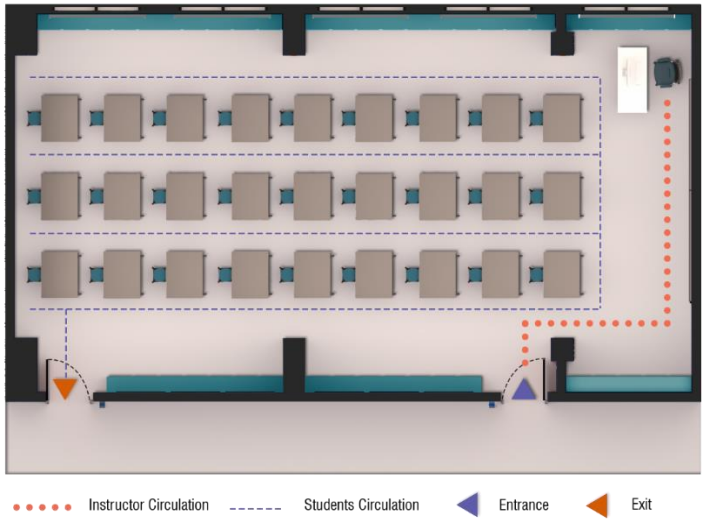

Figure 6: Modified design studio plan layout

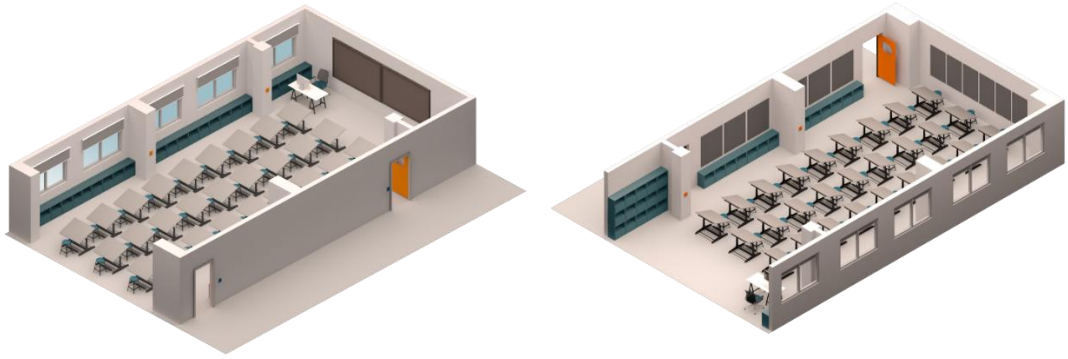

Figure 7: Isometric for the redesigned design studio

For engineering laboratories, different types of labs are available, such as Electronics Lab, Robotics Lab, and computer Lab, the design of the lab will be various depend on the lesson; for example, in Electronic Lab, the benches with chairs are used in addition to the shelves to keep the equipment, while with the Robotics Lab and Computer Lab the desks with chairs are the main furniture of the lab in addition to the computers as well as the Robotics which are going to be designed and programmed by computers.

At the computer Lab, the students will be provided with access to the essential software to complete lessons. Students are also instructed in computer use, programming, and related topics in computer

labs. For the laboratory, the computer plan is in a normal state as shown in Fig. 3. However, there are some disadvantages to this such as the students must turn to the side to view the board, and they are unable to pay attention to the board because of the tables, the students are not aligned in the same direction. For this reason, it is recommended to rearrange the plan layout horizontally with all tables facing the same direction, as shown in Figs. (8-9). Also with the new arrangement, it is suggested that a 3D printer be placed in the newly created space adjacent to the door.

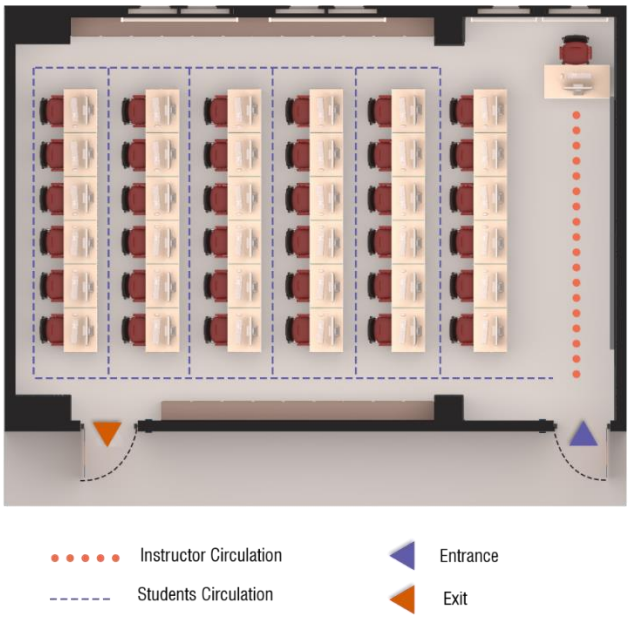

Figure 8: Modified laboratory plan layout

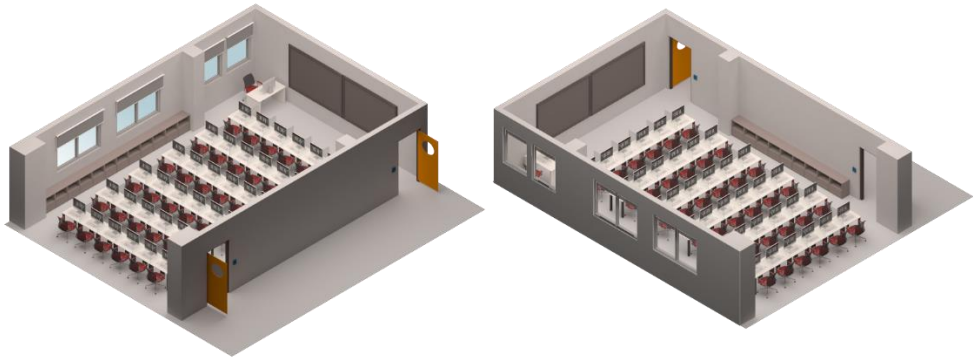

Figure 9: Isometric for the redesigned laboratory.

4.2 Design the Smart System

In this work, the smart learning environment means the electronic system that implemented at each classroom/ laboratory. The schematic diagram for the system is shown in Fig. (10), this schematic diagram is divided into two subsystems, both are connected to the same controller.

The first subsystem will be responsible to open the hall's door as well as take the attendance for the student automatically, the student needs first to scan the student ID at the RFID Scanner that placed at

the entrance of the classroom, then once the ID is recognized the door will open automatically and the attendance will be taken for that student.

Opening the door of the class/lab, will not only depend if the student registered to join the class or not, but also it depends on the daily checking of the students' body temperature, which become an obligatory after the pandemic, to ensure the safety for the university's staff and student. According to that, at the entrance of the class/lab there is a contactless thermometer to check the student body temperature, if it is more than the normal range, the door will not be opened and will give a warning message to the student as well as the university's administrations, to check the reason for that, this is useful to protect the university's students and staff from a possibility of any type of sickness that cause fever such as Covid-19.

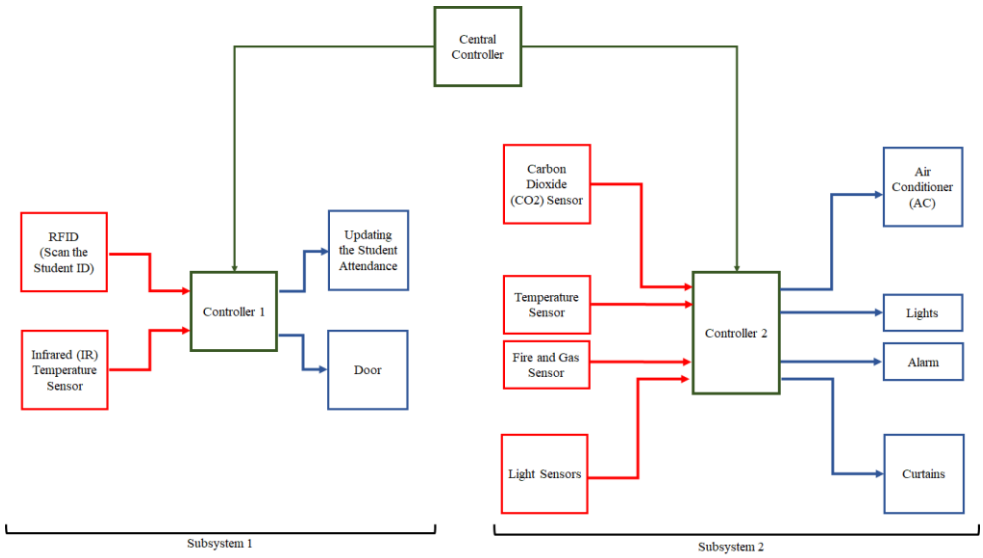

Figure 10: Schematic Diagram for the smart system

The second subsystem is responsible for four main functions, the first function is to check the room's temperature and control the AC system accordingly, if the temperature more than or equal to 23, the air-conditioning system will run the cooling system while if the temperature less than or equal to 20 then the air conditioner will run the heater system. Also will control the curtains and light, based on the level of light inside and outside the class/lab, this will be varied according to the time from the day (morning, afternoon, evening) and the time from the year (winter or summer), for example in winter, most of the days are cloudy so the curtains will be kept open while the light will turn on during the day time, however at evening the curtains can be closed, this is different from summer, in the morning, the curtains could be kept open and the light off, in the afternoon the light of the sun will be stronger so the curtains will be closed and the light on.

The second function is ventilation system; when the lecture conducting in any close hall/lab the percentage of the CO2 will increase, according to the breathing of the students, this can be harmful to the students as well as interrupting the class because it could cause sleepiness, also after the pandemic, this become one of the main concern for conduction the class on campus, this is why the hall/lab will include a ventilation system which is going to check the level of the CO2 in the class and based on that will run the system to change the air and brought a fresh air, according to the studies the percentage of the Carbon Dioxide should not be more than 400 molecules which is 0.04% from the air.

The function of the system is the safety system, which is used to protect the class/lab from any fire or gas leak, therefore a sensor that detected them will be implemented connected with the Alarm system to ensure the safety of the students and the staff.

The last function of the subsystem is controlling the light of the classroom by implementing multiple light sensors all around the learning spaces, and all of them connected to the controller which is going to turn on/off the light of the classroom as well as open and close the curtains.

5. Implementation

This system implemented by using Arduino as a Main controller, which is connected with the sensors and actuators based on the function of each subsystem. For the first subsystem, the Arduino is implemented as a main controller which is connected with the RFID system to take the students attendance, the RFID system is used to scan the ID of the staff and Students, the IDs for the staff and students are predefined and will be updated according to the weekly schedule and the usage of the class, also the thermometer is implemented based on a contactless IR sensor which is connected directly to the Controller. The main door will be connected to the same controller and will be opened automatically if the scanned ID is registered to join the conducted lecture at the hall and the temperature of the students less than 37°; the range of the body temperature will be decided by the programmer and can be adjusted according to the situation. The working sequence of the first subsystem is shown in Fig. (11).

For the second subsystem, the Arduino is also implemented as a main controller which is connected with various sensors and actuators to perform the functions. The first function was controlling the Air-condition/heater according to the room temperature, the controller will be connected to temperature sensor to detect the room temperature then accordingly will turn on/off the air-condition/heater depending on the season, the reading temperature will be compared with a default temperature that is already defined to the system for example during summer time the optimal room temperature is 23°, so the reading temperature will be compared with 23°, if it is higher the air-condition will turn on, however if it is lower the air-condition will turn off. While during winter, the optimal room temperature could be 30°, so the reading temperature will be compared with 30°, if it is less the heater will have turned on and if its higher the heater will have turned off; comparing the reading temperature with the default temperature to turn on/off heater/cooler will be repeated every few minutes to provide a room with a stable temperature.

The second function is controlling the light of the class halls/labs and the curtains, by implementing light sensor inside the learning space as well as at the window, which are connected to the controller (Arduino in this project) to control the class lights as well as opening and closing the curtains. This will depend on the time of the day as well as the season, for instance during summer, most of the days are sunny, so the curtains will be kept close and the light will remain on, while during the winter, the light sensor that implemented at the window will detect the outside light, if its cloudy the curtains will remain open and the class's light will be tuned on, however if it sunny outside or at the time of sunset, the curtains will have closed and the light's will have turned on.

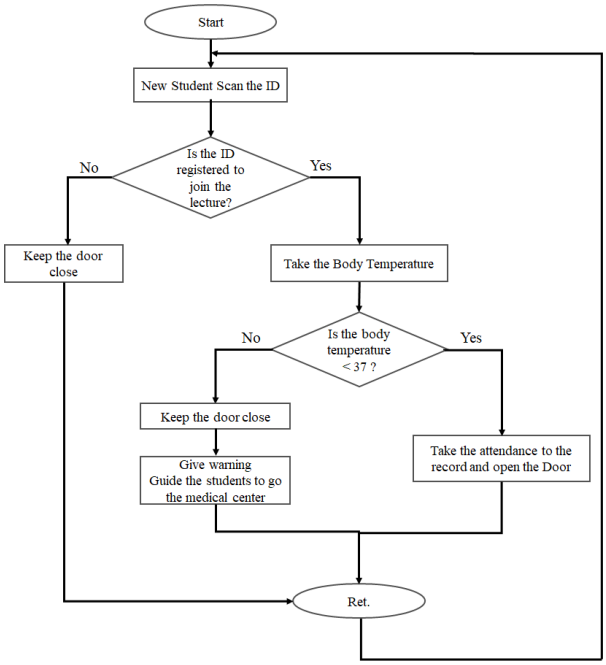

Figure 11: Flow diagram for the working of the first subsystem

The third function is controlling the ventilation system; the controller (Arduino) connected with CO2 sensor along with humidity and temperature sensors to ensure the quality of the air, which helps to study and work in a healthy environment. The CO2 sensor will measure the level of the carbon dioxide in the air and will send it to the controller which will compare the reading value with the ideal percentage of healthy air according to the standard, the percentage of CO2 in the healthy air in our atmosphere should be less than 0.04% (400 molecules), if the reading value higher than this number the ventilation system will run, while if its less, the ventilation system will be stay tun off, this controller will read data from this sensor every 5 minutes.

The last function is ensuring safety at the learning space, by implementing fire and gas sensor which are connected to the controller (Arduino), in case of any smoke or gas leak the sensor will detect it and run the alarm system to warn the people in the class to evacuate the place, with the design of the class hall an exit door has been added to each class to speed the evacuation. The flow diagram to describe the process of the second controller shown in Fig. (12).

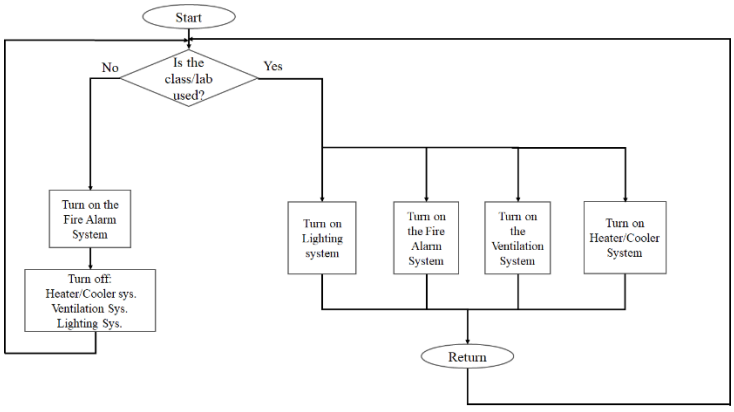

Figure 12: Flow diagram for the working of the second subsystem

For each learning space, smart-screen and white board are used. The smart screen used to display the lecture, also it can be used by the instructor to write and derive mathematical equation, draw geometrical shapes, and do sketch for design courses. This screen usually adapted with technology and it can be used for live lecture for distance lecturing, online training courses and workshops by using different software such as webinar, zoom and google meet. While the normal white board can be used by the instructor for traditional way of teaching when it is required. In additional to the smart screen, the sound system is implemented around the learning space, microphone is placed near the instructor and the speakers all around the hall, this can guarantee the voice of the instructor can be heard from all the students in the hall.

By merging the smart system with the redesigned learning spaces, we can get the smart learning environment for the class hall, design studio and laboratory as shown in Fig. (13), Fig. (14) and Fig. (15) respectively.

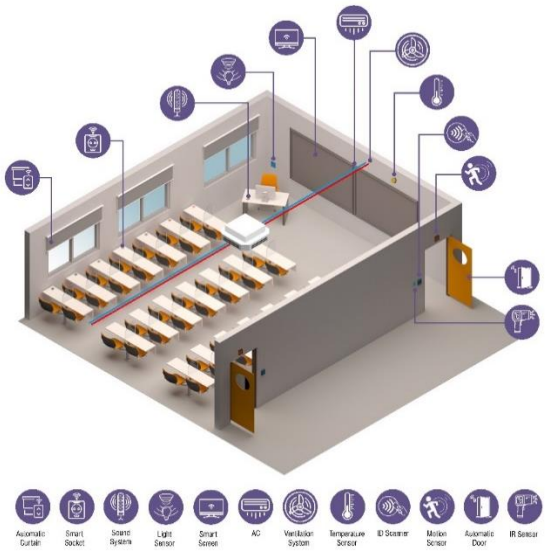

Figure 13: The implementation of the smart system in the class hall

Figure 14: The implementation of the smart system in the design studio

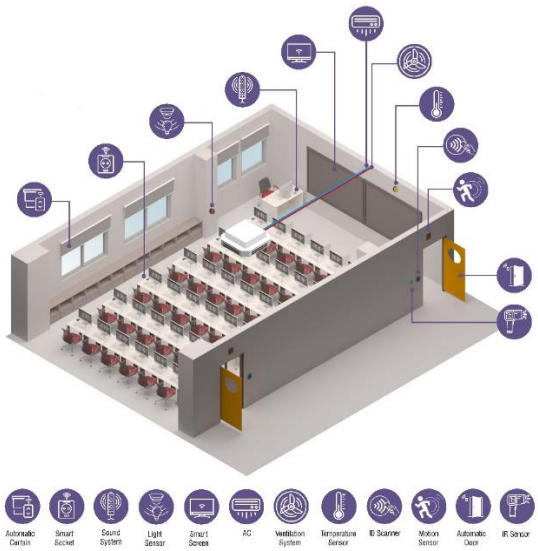

Figure 15: The implementation of the smart system in the laboratory

6. Discussion

According to a number of academics, the term "smart" refers to the use of various intelligence technologies. A system's use of a certain level of artificial intelligence technologies is what makes it "smart." The level depends on the need, the AI technologies that are currently available, and budgetary constraints. Consequently, it is expected that a smart education system will produce an intelligent environment for education.

The smart education design steps have been developed specifically to be generic. This enables the steps to be utilized in numerous intelligent education designs. Due to the novelty of the concept of smart education, the design of smart education systems and courses will necessitate the assistance of smart education specialists until the concept is widely adopted. These professionals will tailor these steps to the specific requirements of educational institutions. In the early stages of smart education, support from experts in smart education will be crucial.

Compared with the works of the other researchers, Cebrián (2020), Çeken (2022), Cheung (b) (2020), and Yue (2008), the smart learning environment was focused on implementing the technology with the educational environments without considering redesigning the class to meet the new requirements for distancing, which became most people's concern after the pandemic.

In this work, the learning environment at the engineering faculty of TIU has been modified to be a smart learning environment. Two main aspects have been considered, first was redesigning the learning spaces at TIU according to international standards, and the second aspect was implementing a smart system at each learning space to ensure a comfortable, safe, and secure environment. The learning spaces at TIU can be divided into three types: design studio, classroom, and laboratory. Redesigning the learning spaces will depend on the type of learning space. For example, redesigned the classroom by reducing the number of seating areas, improving the circulation, and making the secondary door accessible, as well as adding a portable divider to the tables to prevent the possibility of spreading viruses, as shown in Fig. (4). While redesigning the studio halls, we focused on reducing the number of boards and expanding the area between the boards for easier circulation, as shown in

Fig. (6). However, redesigning the laboratory by focusing on changing the direction of the seating area to be horizontally aligned with all tables facing the same direction as shown in Fig. (8).

The second aspect of creating a smart learning environment at TIU was focusing on implementing a smart system at each learning space; the smart learning is in charge of ensuring the safety and security of these spaces' users. The smart system is mainly based on a controller that is connected with different sensors and actuators to provide a safe, secure, and comfortable environment. The types of sensors and actuators will be based on the application. For instance, to ensure safety and security, a temperature sensor has been implemented at the entrance of the hall. The second sensor is the body temperature sensor, which will measure the people's body temperature and then control the door if the body temperature is within the normal range. Otherwise, it will notify the administrative about the case and will not allow the student to join the class, the second sensor was the gas and fire detector to warn people if there is any case of fire or gas leak in the class/lab, and the third sensor is the carbon dioxide which is used to detect the level of the CO2 in the class/lab and run the ventilation system accordingly. To provide a comfortable environment for the users of the learning spaces, a system was implemented that uses sensors to control the AC, lights, curtains, and door. For example, temperature sensors are used to control the AC, while indoor and outdoor light sensors are used to control the turning on/off the lights and opening and closing the curtains. There are also RFID sensors implemented at the entrance of the class to control the door, if the student's ID is predefined to the system to join the lesson. The implementation of the smart system was shown in Figs. (13, 14 and 15).

7. Conclusion

Physical factors, including furniture, space, air quality, and smart system applications contribute to classroom teaching and learning comfort levels. In this study the learning spaces of the Engineering Faculty at Tishk International University - Iraq have been adapted to be a smart learning environment, by considering the structure that is adaptable to the needs of its users, comfortable, equipped with multiple socially and digitally connected resources, personalized, clean, accessible to its immediate environment and the world, and safe for its users and its technological equipment. Also, by implementing a smart system in each hall to ensure safety and security, the smart system include controller that is connected to several types of sensors as well as actuators to provide a comfortable learning environment to the staff and the students.

The results of the study show the ability to adapt any traditional learning environment to be smart in terms of redesigning the space and add smart system that ensure safety, security and focusing on the way to improve the quality of learning spaces.

As future work, we will implement the smart learning system by modifying the existed learning spaces at TIU, as well as focusing more on the design space to be smart space in additional to the smart learning environments.

References

Bautista, G., & Borges, F. (2013) Smart classrooms: Innovation in formal learning spaces to transform learning experiences. ResearchGate. https://www.researchgate.net/publication/297828424

Cebrián, G., Palau, R., & Mogas, J. (2020). The smart classroom as a means to the development of ESD methodologies. https://doi.org/10.3390/su12073010 Available from: www.mdpi.com/journal/sustainability (Accessed on 12 April.2021).

Çeken, B., & Taşkın, N. (2022). Multimedia learning principles in different learning environments: a systematic review. *Smart Learn. Environ.* 9, 19. https://doi.org/10.1186/s40561-022-00200-2

Cheung, S. K. S. et al. (2020a). (Eds.): ICBL 2020, LNCS 12218, pp. 365–377. https://doi.org/10.1007/978-3-030-51968-1_30

Cheung, S. K. S., et al. (2020b). (Eds.): ICBL 2020, LNCS 12218, pp. 353–364. https://doi.org/10.1007/978-3-030-51968-1_29

Dron, J. (2018). Smart learning environments, and not so smart learning environments: a systems view. *Smart Learn. Environ.* 5, 25. https://doi.org/10.1186/s40561-018-0075-9

Fraser, B. J. (1981). *Learning environment in curriculum evaluation*: A review, Oxford: Pergamum Press.

Gambo, Y., & Shakir, M.Z. (2021). Review on self-regulated learning in smart learning environment. *Smart Learn. Environ.* 8, 12. https://doi.org/10.1186/s40561-021-00157-8.

Martin, A. J., Nejad, H. G., Colmar, S., & Liem, G. A. D. (2013) Adaptability: How students' responses to uncertainty and novelty predict their academic and non-academic outcomes. *Journal of Educational Psychology, 105*(3), 728-746.

Mohammed, S.B., Taha, M.S., Mohammed, R.B., Mamand, S.A., & Mohammed, D.A. (2021). Teaching methodology for interior design studio-i during covid-19 pandemic at Tishk International University. *Eurasian Journal of Science & Engineering, 7*(1), 185-196.

Vijayabaskar, V. (2020). Smart classrooms in schools in Sri Lanka: A case study on the design and use of smart learning space.

Watters, C. A., Keefer, K. V., Kloosterman, P. H., Sommerfeldt, L. J., & Parker, J. D. A. (2013) Examining the structure of the internet addiction test in adolescents: A bifactor approach. *Computers in Human Behavior, 29*(6), 2294-2302

Wong, A. F. L., & Fraser, B.J. (1998). Environment-attitude associations in the chemistry laboratory classroom. *Research in Science*, 64, 29-40.

Yang, U., Pan, H., Zhou, W., & Huang, R. (2018) Evaluation of Smart Classroom From the Perspective of Infusing Technology into Pedagogy. *Smart Learning Environments, 5*(20), 2-11

Yue, S., Naoki, M., Toru, I., & Yuanchun, S. (2008) Open smart classroom: Extensible and scalable smart space using web service technology. *Department of Computer Science and Technology*, 3, 428-439