The role of building information modeling(BIM) in the development of architectural education

case study (the Environmental Architecture Program at Tanta University)

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Abstract:

At the beginning of the current century, with the advancement of computer technology, a new system emerged that relies on drawing and three-dimensional modeling with the definition and description of all elements of building, technology and software have advanced greatly until the features of the modern system were determined and became more defined and approved in many companies and organizations for design and construction, which is the Building Information Modeling (BIM). Despite the importance of this system, its work in Egypt is limited to foreign institutions, and there is no clear vision for its development and exploitation in urban development and in the sustainable design of new cities and communities.

Therefore, we review in this research the importance of the BIM system and ways to integrate it into the institutions concerned with construction and reconstruction as an interactive system that helps to achieve maximum benefit and come up with the least errors in design and implementation, and its role in the process of developing architectural education and the development of design methods for facilities and methods of training engineers and students in universities and educational bodies, and that is through three main axes the first axis deals with the levels of knowledge by applying building information modeling and its dimensions, the second axis studying strategies for teaching building information modeling technology in architectural education courses, the third axis studying the relationship between the cognitive levels of BIM, its dimensions and its impact on the strategies of teaching courses, in order to present a proposal to integrate building information modeling technology applications to develop architectural education in Egyptian universities.

Key words

(building information modeling, BIM, architectural education, Environmental Architecture)

الملخص:

في بدايه القرن الحالي ومع تقدم تكنولوجيا الحاسبات ظهر ملامج نظام جديد يعتمد على الرسم والنمذجه ثلاثيه الابعاد مع تعريف وتوصيف كافه عناصر المنشا وتقدمت التكنولوجيا والبرمجيات بصوره كبيره حتي تحددت ملامح النظام الحديث واصبح اكثر تعريفا واصبح معتمدا في كثير من الشركات والهيات الخاصه بالتصميم والانشاء وهو نظام BIM (Building Information Modeling) ورغم اهميه هذا النظام الا ان العمل به قي مصر مقتصر على المؤسسات الاجنبيه ولا يوجد رؤيه واضحه لتطويره واستغلاله فى التنميه العمرانيه وفي التصميم المستدام للمدن والمجتمعات الجديده.

لذلك نستعرض فى هذا البحث اهميه نظام ال BIM وطرق ادماجه في المؤسسات المعنيه بالانشاء والتعمير كنظام تفاعلي يساعد على تحقيق اقصي استفاده والخروج باقل الاخطاء في التصميم والتنفيذ، ودوره فى عمليه تطوير التعليم المعماري

وتطور اساليب التصميم للمنشات وطرق تدريب المهندسين والطلبه في الجامعات والهيئات التعليميه ، وذلك من خلال ثلاثه محاور اساسيه (المحور الاول) يتناول المستويات المعرفية بتطبيق نمذجة معلومات البناء وابعادها ، (المحور الثانى) دراسة استراتيجات تدريس تقنية نمذجة معلومات البناء بمقررات التعليم المعمارى ،(المحور الثالث) دراسة العلاقه بين المستويات المعرفية ل BIM وابعادها وتاثيرها على استراتيجيات تدريس المقررات وذلك لتقديم مقترح لدمج تطبيقات تقنية نمذجة معلومات البناء لتطوير التعليم المعماري بالجامعات المصرية .

الكلمات المفتاحية:
البناء والمعلومات والتعليم والبيئية والهندسة المعمارية

Search objective:
Analysis and measurement of the use of the BIM system and its impact on the development of architectural design by discussing its application in some international universities and drawing out plans and methodologies for integrating the BIM system into architectural education courses in Egyptian universities and academic organizations.

Research problem:
The rapid development of technology and computer systems (such as the BIM system) in an accelerating way that we notice, which plays an important and major role in the design, implementation and project management of construction and building projects, but with this great development we do not notice the interest in integrating it into the construction industry in Egypt and its slow in terms of benefiting from these modern systems, and not keeping pace with this progress in the development of academic education specially architectural education, and its regulations in line with these systems and software related to the field of design and construction.

Research Methodology:
The method of the research depends on two approaches, the inductive method and the analytical method, where each of them divides the research into two main parts, and the task of each part is:
The inductive approach: discussing the definition of building information modeling, the reasons for its use and the various applications of it in the field of construction, as well as its levels and dimensions, and the challenges facing the application of BIM.
Analytical approach: studying and analyzing models of regulations for distinguished universities at the global level that have applied BIM systems in developing the design and construction industry and in developing academic education outcomes, and then come up with a proposal that clarifies the considerations that can be taken in integrating modern BIM systems (in the academic field and helping in developing its regulations and thus developing the field of design and construction in Egypt.
Applied approach: Applying the proposal that was reached as a result of the analytical study on one of the models of educational institutions in Egyptian universities - the Environmental Architecture Engineering Program - at the Faculty of Engineering, Tanta University - and it is one of the credited-hours programs.

1-The introduction:

The construction industry is changing at accelerated steps, and the development of its technical tools is considered the most important feature of this change and in the near future the use of BIM technology will be imposed in the AEC industry all over the world and therefore those who have not adapted to the new change and are still not ready for it will affect their companies. The industry and academic institutions currently agree on the need to keep pace with the successive developments in information technology and that the greater employment opportunities offered by BIM technology to its users make it necessary for any academic body to reconsider the curricula it teaches in order to accommodate this technological shift from a scientific point of view, it provides these modern technical tools in its programs. The role played by academic institutions is considered one of the keys to success or failure in the application of educational quality standards that distinguish it from each other.

2-The concept of BIM systems and their definition in the construction industry:

The National Building Information Model Standard (NBIMS) defines Building Information Modeling (BIM) as the digital representation of the functional and physical characteristics of a building [1],Where the principle of building information modeling systems and analysis of thermal loads, heating and cooling systems, structural loads and others within a central database, as the construction needs to document all the necessary information in the fastest and easiest way that guarantees quality in outputs and non-repetition of work, and therefore the promotion of the use of electronic forms in construction operations holds promises to save time and money, reduce claims and raise construction productivity, especially in complex projects that have become difficult to be controled by the current methods [2].

2-1 Reasons for the trend of BIM technology:

Table No. 1 Reasons for the trend of BIM technology

Design stage problems	Implementation stage problems
1- Weak perception of the project owner and consequently the difficulty of understanding or imagining the final form of it and the lack of full understanding of its requirements and desires in the early stages, so orders are issued to change a random and unthoughtful form to add or remove part of the project, resulting in an increase or decrease in the materials used in addition to changes in plans, which leads to delays and increases in the time and cost of the project. 2-The low efficiency of the cost estimation process for several reasons, including the semi-manual inventory of construction	1- Considering the contractor the last party to be included in the construction projects, which results in the issuance of a large number of inquiries requests during the implementation phase. The large number of inquiries requests is an indication of two things: A - The design lacks all the information needed by the contractor to receive the project. B- The contractor's weak experience in implementing some parts of the project, especially the complex and large, complex and high-tech projects.

quantities, which results in inaccuracy and high error rate. 3- Inaccuracy in determining the total time of the project because the design process is carried out in isolation from the scheduling stage. 4-The lack of an efficient mechanism to ensure coordination between the plans in the event of changes in the design.	2- Weak coordination between the various works of the project and its services, and weak communication channels between the project parties. Therefore, points of collision and overlap between the works are often not discovered except in the implementation phase, which results in an increase in the processing time that can be avoided in advance, which in turn affects the time period and the total cost of the project.

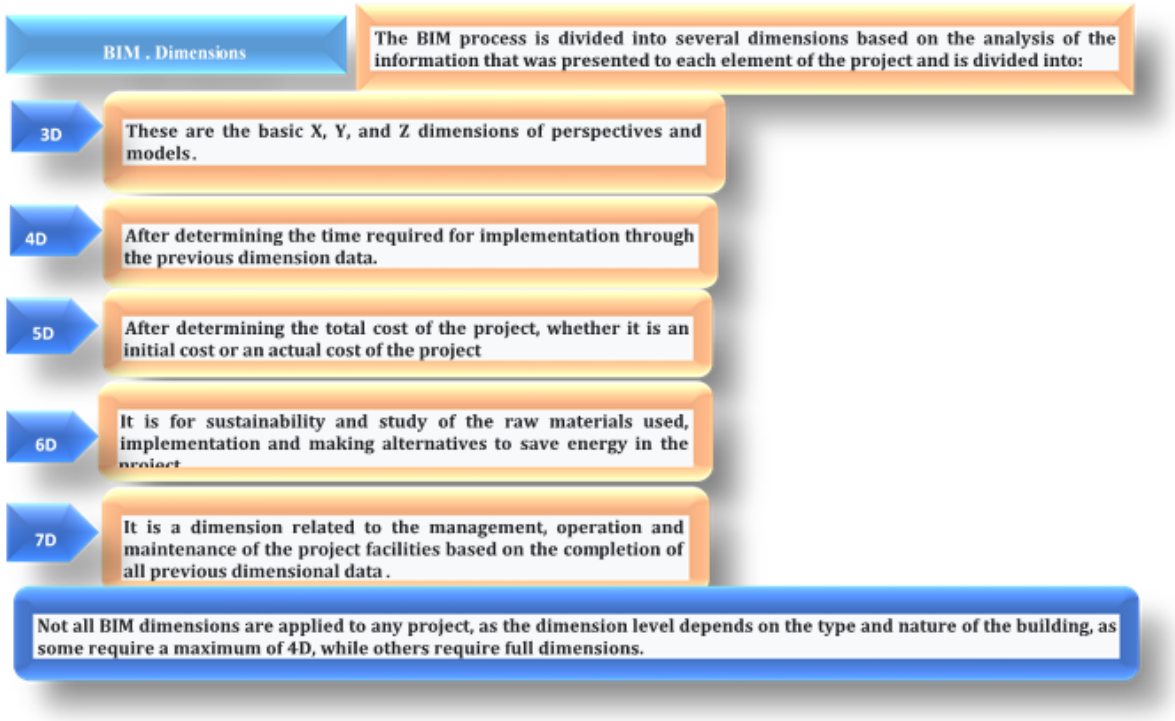
2-2 BIM application levels:

Zero level: It is the level of CAD and the level of non-cooperation. Only lines and arcs are drawn, whether on paper or on computer.

The first level: focuses on a three-dimensional model

The second level: embodies the capabilities of the information model, simulating and facilitating the transfer and exchange of information, which necessarily works on a single model.

The third level: It is the integration so that the work is on one platform and enables real-time dealing. Everyone is working on the same file, you do not have to import and export, but work on the same file in all matters such as model work, time, cost and other dimensions.



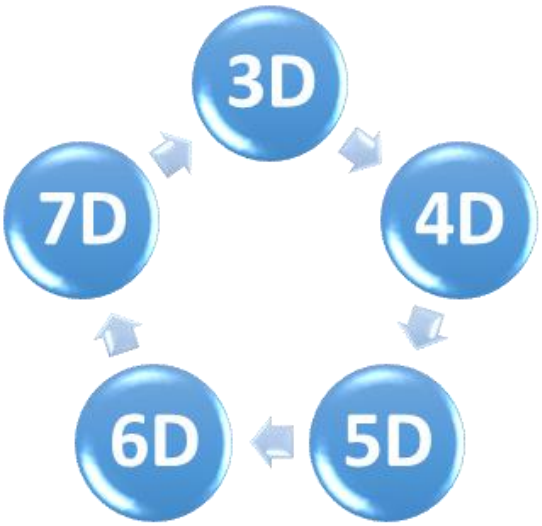


Figure (1): BIM. Dimensions [3]

2-3 Building information modeling application limitations:

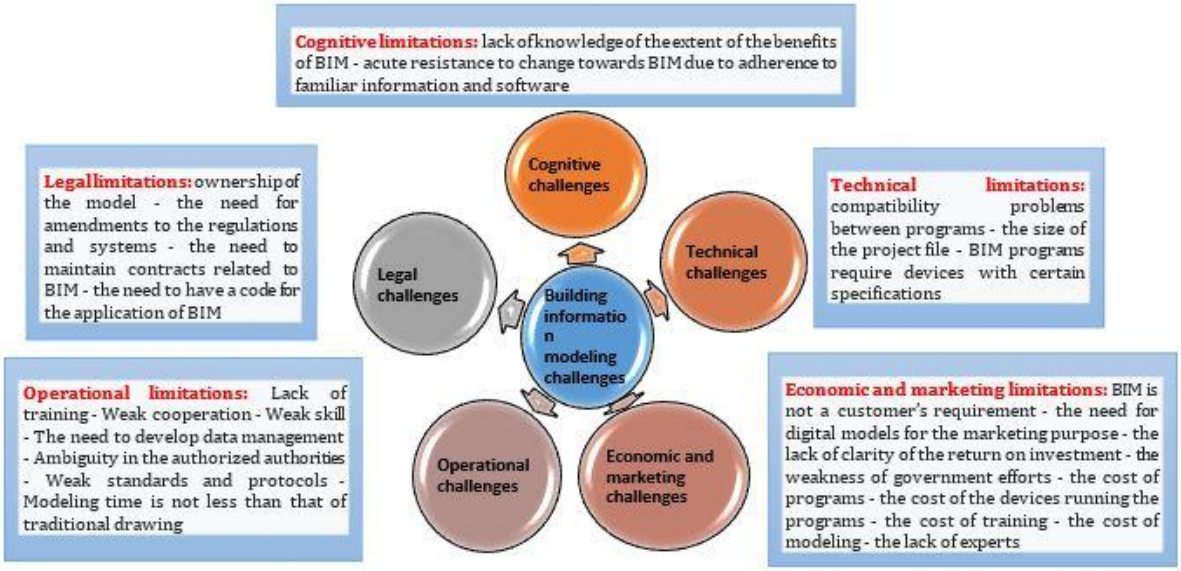


Figure (2): BIM. limitations [4]

2-4 Advantages of using Building Information Modeling:

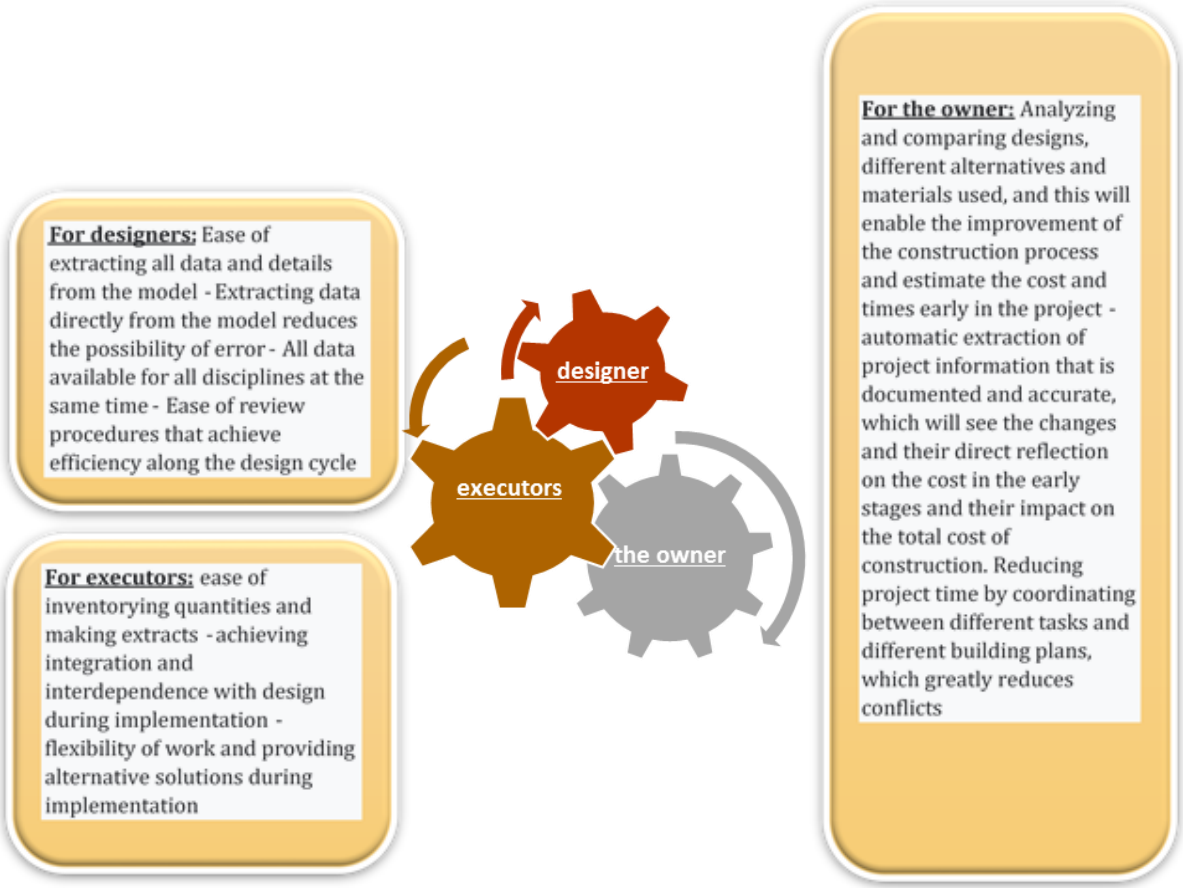


Figure (3): Advantages of using Building Information Modeling

2-5 The axes affecting universities' strategies for integrating BIM systems into the curricula:

Through the study of educational strategies and curricula that allow the integration of BIM systems into the academic study of many of the leading universities in this field, they had a set of common goals, the most important of which were[5]:

a. Developing the educational process and academic regulations to integrate the BIM teaching process into the academic curricula.

b-Make mid-term plans and curricula with specific frameworks for teaching BIM in the Faculty of Engineering within the different departments of the relevant university rather than individual initiatives with teaching programs with different curricula and always based on isolated initiatives that are not coordinated across departments and universities.

c-Cultural and scientific orientation work with BIM systems and other modern systems related to the construction industry.

d- Focusing on preparing well-qualified graduates for the modern labor market, which currently focuses on the collaborative and multidisciplinary processes adopted by BIM systems.

These goals have resulted in some broad lines that represent the main axes of work proposed by specialists and academics in universities, and these main axes are [6]:

The first axis: Supporting universities for the process of propaganda and cultural and scientific awareness of BIM systems and benefiting from them.

The second axis: developing the academic curricula for students and amending the regulations of those curricula in proportion to these new inputs.
The third axis: Qualifying academic cadres to deal with BIM.
Which can be represented in the following form:

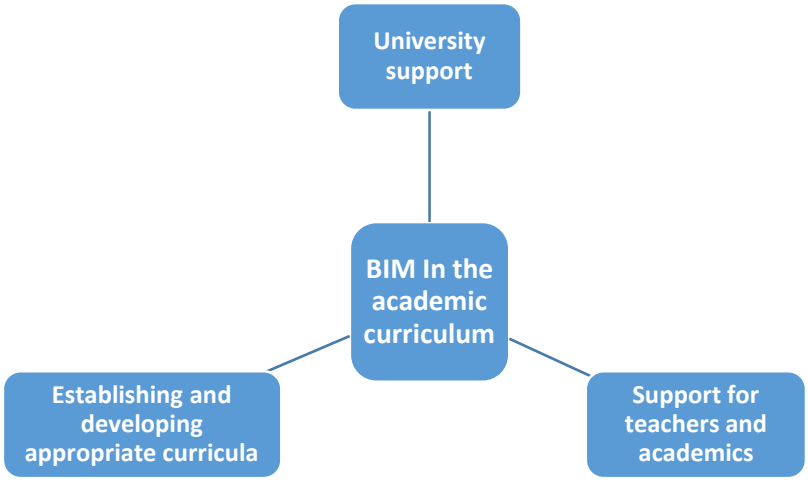


Figure (4): The axes affecting universities' strategies for integrating BIM systems into the curricula

It is certain that these main axes were dealt with by each university from different angles, indicating its vision and the opinion of the researchers. In the following, the common points that separate each of the three axes will be addressed [7]:

Table No. 2 summarizes the concept of universities support axis to integrate BIM

Supporting universities for the process of propaganda and cultural and scientific awareness of BIM systems and benefiting from them		
Support type	**Moral support**	Financial support
١	Encouraging research paper and researchers interested in this process (transition to BIM).	**Organizing and providing places for conferences and seminars.**
٢	Adopting seminars and conferences that discuss the topics (transformation to BIM).	**Providing suitable places for training courses and preparing them.**
٣	Encouraging external research centers to work inside the university.	**Providing financial and technical support for the work of platforms and websites, and organizing training courses interested in interactive teamwork.**
٤	Encouraging the organization of independent courses from private training centers to introduce the BIM system.	

The second axis: developing the academic curricula for students and amending the regulations of those curricula in proportion to these new inputs.

It is considered the most important practical axes for integrating BIM systems into the academic education process, and it has gone through several common stages in many universities around the world and is still undergoing development and improvement. These stages can be summarized in the following table [8]:Table

No. 3 summarizes the stages of developing academic curricula and regulations.

	stage	Important contents
the stages of developing academic curricula and regulations	Curricula and individual initiatives	A stage common to all universities, and it began to be taught as programs for 2D and 3D graphics in technical subjects or in limited workshops.
	Elementary education curricula	BIM was integrated with traditional academic curricula, but the subject matter was limited to improvements in technical aids such as computer-aided drawing (CAD) materials.
	Interactive Curriculum	Preparing comprehensive programs that contain traditional academic materials, accompanied by practical materials, including BIM programs. Interactive curricula appeared for teaching BIM for each academic level in proportion to the theoretical experience specified for each academic level.
	Multidisciplinary workshops	For advanced educational stages aware of the concept of project management, which received practical training and students from various departments participated in it.
	External training support	Approval of external training in contracting companies and design offices that adopt BIM programs to work in them throughout the specified training period.

-**The third axis:** training and qualifying academic cadres to deal with BIM:

Because of the necessity for faculty members to deal with BIM programs in the new curricula that universities sought to implement, this required a necessity to understand BIM, its way of working and its capabilities. Therefore, in most universities that sought to implement BIM in their curricula, this was a fundamental problem in applying methodologies, so many training programs and initiatives appeared to support members of teaching staff to find appropriate ways to teach BIM in their current curricula and courses and to provide them with theoretical and scientific knowledge to do so.

-These initiatives constituted an individual effort in the beginning by organizing some seminars for faculty members, developing ideas and exchanging experiences among them in this field. These seminars and conferences were repeated in most universities and institutes and became held periodically and their topics developed according to different developments and this development went through two phases [9]. These stages can be summarized in the following table:

Table No. 4 summarizes the stages of development of curricula for training academic cadres

	stage	important contents
Stages of development of curricula for training academic cadres	stage of conferences and traditional seminars	Organizing traditional conferences that have a schedule and discuss research published in the field and seek to solve some problems, such as the periodic conference of the American Institute of Architects entitled (BIM III) and the conferences of the University of Florida in 2007.
	Stage of medium-term training program	A new influence has been introduced to the traditional conferences, which is the design offices and contracting companies that represent the construction industry market in the world operating under the BIM system. -Ope BIM course, financially supported by Helsinki Metropolitan University of Applied Sciences, to train those interested in BIM. The course was divided into two sessions, starting from fall 2012 and spring 2013, and all dimensions and aspects of dealing and benefiting from BIM in academic education were discussed. This session achieved many successes, according to the opinions of the attendees.

3-Strategies for teaching Building Information Modeling (BIM) technology in educational curricula:

Despite the importance of BIM technology for the construction industry and its importance for cost estimation and project scheduling, however, most schools limit the use of BIM technology to teach how to make 3D models, optical visualization and construction work (2012., Joannides al et al.).

Schools and colleges have relied on two main strategies for teaching BIM technology:

1 - One-on-one courses, 2 - Interactive design studio.

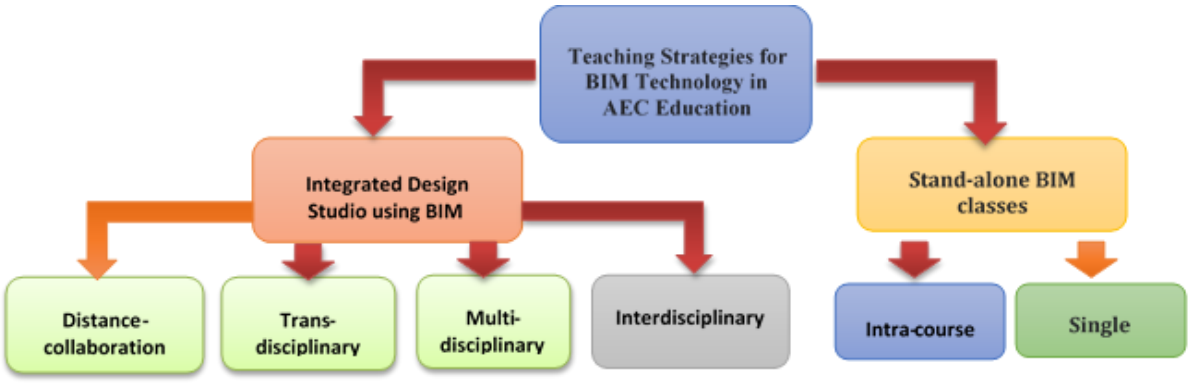


Figure 5: Teaching Strategies for BIM Technology in AEC Education

First strategy: Stand-alone BIM classes

In which BIM technology is taught as 3D modeling programs and this method began in the mid-nineties in two universities in the United States of America, the Georgia Institute of Technology and the University of Texas, and is still used in most universities (2012., Brewer et al) and these

courses were called by many names such as (Advanced CAD - 3D Visualization - Computer Applications for Professional Practice - Digital Visualization). It is either offered as a standalone course or as an integrated course within another course, mostly design studio, building technology, construction management or workshops.

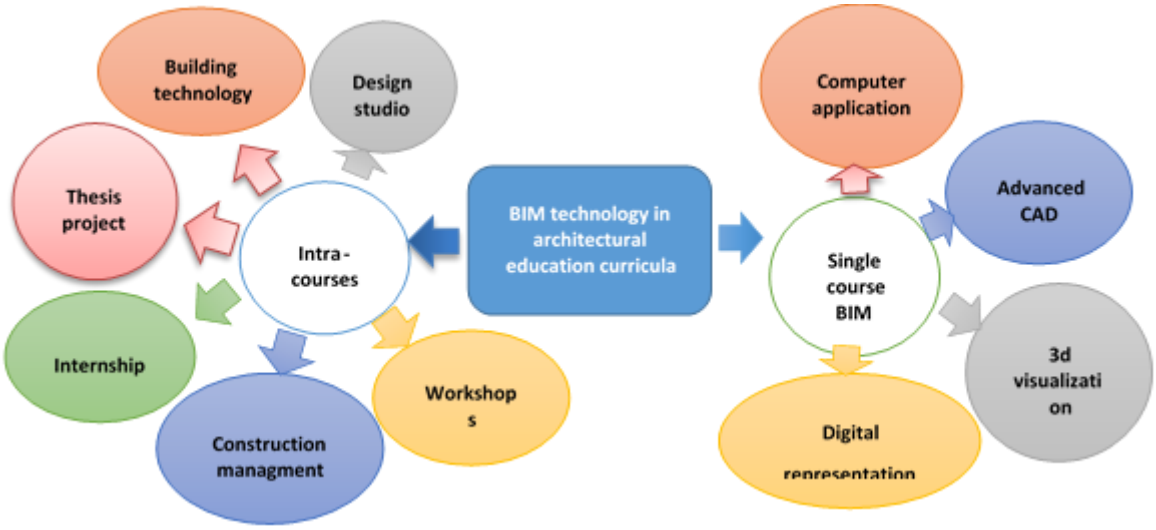


Figure 6: Teaching BIM Technology in single Courses

Teaching (BIM) as a tool for 3D design helps the student to acquire modeling skills to reach an expert degree in the use of BIM tools, but the student may not be at an appropriate level of expertise, and curricula that teach BIM modeling as a means of introducing BIM tools to students of architecture, engineering and construction should be ACE, but this method is unreliable without including it with the integrated design studio.

Second strategy: An integrated design studio using BIM technology:

It is a method that helps students from multiple disciplines to understand the workflow and to give them a holistic understanding of the architecture and construction industry. The concept of the integrated design studio IDS was introduced in 2006 at the University of Pennsylvania and this method helped students gain knowledge of how to do a project on the ground, and many universities in the States started United States such as the University of Oklahoma and Stanford University to teach BIM within their programs through IDS, and many of them have been granted accreditation from the American Institute of Architects due to the inclusion of BIM technology in the integrated design studio.

Universities have used many technologies to introduce BIM technology in IDS integrated design studios, and many terms have emerged for this, the most important of which are:

a- Interdisciplinary b- Multi-disciplinary c- Trans-disciplinary d- Distance-collaboration

-This is to help students and encourage them to work in a collaborative environment. The first three terms are nearly identical (disciplinary-trans-disciplinary-multi-interdisciplinary) but can be distinguished by clarifying the role of each discipline. The difference between interdisciplinary and disciplinary-multi is how the design problem is introduced. A disciplinary design problem is presented to the entire team within a design studio in contrast to a disciplinary-multi-disciplinary design issue in which the design issue is first presented to one of the directly relevant disciplines (in this case Architectural Students) and then discussed with the rest of the team.

In a trans disciplinary term, students of a scholarly level are engaged with a team in an interdisciplinary or interdisciplinary studio to solve a design problem by providing an opinion or action.

If the university does not have other AEC programs, it can use collaboration-distance practices with other universities, and in all cases, before working with students from other disciplines at the same university or other universities, the student should learn the roles of the disciplines their tasks and previous experience in cooperation.

Table No.5. The relationship between university strategies and teaching strategies to integrate BIM systems into academic education

 			Locations for seminars and conferences	Financial support	University support	University strategies for integrating bim systems
			Physical equipment for the halls			
			Platforms and websites			
			Organizing seminars and conferences	Moral support		
			Organizing training courses			
Teaching strategies for integrating bim	Independent course	Advanced cad	Curricula and individual initiatives		Curriculum development	
		3d visualization				
		Computer applications for professional skills	Elementary education curricula			
		Digital display				
		Design studio	Interactive Curricula			
		Visual communication				
		Environmental Studies				

	Integrative courses	**Construction technology**			
		Digital graphic representation			
		Urban studies			
		Construction management			
		Class projects		**Multidisciplinary workshops**	
		Workshops			
		Training		**External training support**	
				**The stage of traditional conferences and seminars**	**Support for faculty members**
				Medium-term training program stage	

4-Building information modeling (BIM) applications in universities:

-Analytical study of different models of architecture program regulations:

In this part of the research, we will present and analyze different examples around the world of regulations for the study of architecture programs to show the extent to which methods are applied to study building information modeling (BIM) in these regulations. The study included universities of multiple levels (according to the program's arrangement within the architecture programs in the world) and the research will include the following university regulations:

1. Penn State University Bachelor of Architecture Program (United States of America).
2. Liverpool University Bachelor of Architecture Study Program (United Kingdom).
3. Georgia Tech University Bachelor of Science program in Architecture (United States of America).
4. Queensland University of Technology to study a Bachelor's degree in Architectural Engineering (Australia).

Noting that all the regulations of the previous universities are updated according to the semester updates 2020-2021.

Table No.6 Analytical study of different models of architecture program regulations

Penn State University Bachelor of Architecture Program (United States of America)[1]	**About the university and the program**	-Penn State University has a program to study architecture accredited by the National Architecture Accreditation Board (NAAB), which ranks among the strongest programs for studying architecture in the United States of America, especially in the eastern state. -Penn State University is considered one of the leading universities in introducing BIM education into its curricula by adopting integrated curricula based on digital design and integrated design. These curricula were adopted experimentally in the beginning of 2003, and the materials and curricula were officially approved in 2006. -The program was ranked according to the global classification for the year 2020 in the 44th rank globally.
	Units and hours	The number of hours of the study program is 162 credit hours that the student must pass, and the number of points for courses that contain content of digital curricula and BIM technology is 96 credit hours out of the total number of program points.
	Its role in integrating BIM	-There are some elective courses from which the student chooses complementary courses classified into two types: -١General Education Course -٢Supporting Course for Major -The general educational courses consist of the basic educational materials related to engineering, such as (human history - chemistry - engineering physics - mathematics - specialized mechanics - geology - computers and programming sciences - .....) and the college controls through the academic supervisor determining the group of subjects that I have Students choose from them in each semester according to many considerations, and it continues until the third year of study. -As for the materials supporting the specialization, they are materials within the architectural specialization that help to complement the basic materials from a theoretical and applied point of view such as (architectural criticism - introduction to architectural project management - architectural project management - advanced studies in project management - advanced applications in digital manufacturing - advanced studies in design Al-Hadari - advanced studies in building information modeling technology -...)
	Lab	The educational environment is well-equipped with a set of workshops and labs (Building Technology Lab -Form and Material Lab (ForMat) - Advanced Engineering Modeling Lab (AdGeomLab) - Digital Art Design Studio - Computational Textiles Lab - Remote Collaboration Lab - Interactive Environments Lab - The Stuckeman Shop Lab - Test The digiFAB).

Liverpool University Bachelor of Architecture Study Program (United Kingdom)[1]	**About the university and the program**	-The College of Architecture, University of Liverpool has several programs for teaching architecture, but this program is one of the strongest and most recent programs for obtaining a bachelor's degree in architecture granted by the College of Architecture and Civil Engineering at the University of Liverpool. According to the international classification of universities for the year 2020, the program was ranked 163 globally, 27 in Europe and 7 at the level of universities in the United Kingdom. -The program is characterized by development in its scientific and applied content and the application of the latest types of technology used in design and construction in a good environment of laboratories and studios.
	Units and hours	-The College of Architecture, University of Liverpool has several programs for teaching architecture, but this program is one of the strongest and most recent programs for obtaining a bachelor's degree in architecture granted by the College of Architecture and Civil Engineering at the University of Liverpool. According to the international classification of universities for the year 2020, the program was ranked 163 globally, 27 in Europe and 7 at the level of universities in the United Kingdom.
	Its role in integrating BIM	-The program is characterized by development in its scientific and applied content and the application of the latest types of technology used in design and construction in a good environment of laboratories and studios. -The program consists of 4 academic years in the module system, and each year consists of two semesters and an additional summer semester, after which the student is awarded a bachelor's degree in architecture, and the university allows advantages for graduates to obtain a master's degree in a period not exceeding two years. -The number of academic program points is 510 approved points that the student must pass, and the number of points for courses that contain content of digital curricula and BIM technology is 277.5 approved points out of the total number of program points.

	lab	-The college contains a group of modern laboratories available, including: -١Technical Support Workshop: Supports audio, video, multimedia and information technology functions on a daily basis. Providing model-making skills and workshops within the college. -٢Multimedia Printing Lab (PMDS): It is a multi-purpose facility with highly professional equipment, from 3D printers and backlit drawing boards to large format printers and scissors, it enables the user to print, cut, scan and draw to very strict standards. -٣Computer labs: All devices feature Adobe Photoshop, InDesign, Acrobat, Illustrator and AutoCAD -programs and are supported by the University's Computer Services Department (CSD). In addition, the computer lab also contains Rhino for 3D modeling, Grasshopper for parametric modeling, along with Adobe Premiere, Revit, SketchUp and a full suite of Microsoft Office applications installed. Final Cut Pro and Cinema 4D are installed in the Mac suite as well. The school also has a wireless network throughout to allow students to work online and access the university's web-based materials including printing. -٤Photography:The college has a number of faculty who practice architectural photography and provide lessons and technical support from basic concepts of photography to advanced architectural, time-lapse and video techniques. -٥Search parameter:The college has major specialist facilities for science and engineering work including controlled environment rooms, noise transmission suites, and an anechoic chamber. -٦Workshops:The school has two model making workshops, a laser booth and a CNC room. Equipment includes a 3-axis CNC router, four 3D printers, five laser cutters, and a full set of traditional analog woodworking machines including band saws, table saws, various sanders, spray booths, ferrite saws, power tools and hand tools. -٧library: The library is extensively stocked with all major architecture books, monographs and periodicals. Plus, all major architecture and planning journals. In addition to the library's public inventory, students can consult private and archive collections containing unique architectural drawings.

.Georgia Tech University Bachelor of Science program in Architecture (United States of America)[1] [2]	About the university and the program	Georgia Tech University bylaws for obtaining a Bachelor of Science in Architecture, updated for the year 2020-2021. -Georgia Tech's Bachelor of Architecture program offers an educational experience grounded in design, technology, and science. Students learn how to think critically about technology and how to apply new tools to architecture and the challenges of building a better world. -The Bachelor of Science in Architecture program is a four-year program focused on the world of technology and design. It prepares students for postgraduate study and prepares them as a practicing architect with a variety of career paths and entrepreneurial opportunities in areas dedicated to making innovations in design, planning, construction and business. -According to the International Classification of Universities for the year 2020, the program was ranked 29th globally.
	Units and hours	The number of hours of the study program is 124 credit hours that the student must pass, and the number of hours of courses that contain content of digital curricula and BIM technology is 72 credit hours out of the total number of program hours.
	Its role in integrating	-There is a list of elective courses that include a number of other fields such as (interior design - industrial design - urban studies - land division) from which the student chooses appropriate courses under the supervision of his supervisor.
	lab	-Within the university, there is a group of modern laboratories and workshops that meet the latest educational and training requirements that students need. -Design Workshop - Hineman Research Building - DFL - The Digital Building Lab (DBL) - High Performance Building Lab (HPBL) - Shape Computing Lab - SimTigrate Design Lab - Spatial Futures Lab.

.Queensland University of Technology to study a Bachelor's degree in Architectural Engineering (Australia)[1]	About the university and the program	-The University of Queensland University of Technology has strong programs to study architecture internationally accredited by several international architectural organizations, and the program that will be presented below is classified as one of the strongest programs to study architecture in the country of Australia and ranked No. 51 globally according to the classification of the year 2020. -To obtain a Bachelor of Design degree in architecture, it is required to cover 384 points in a period of 4 academic years, each year divided into two semesters. -The program consists of 18 modules in the core discipline and four modules common to all six design disciplines (Architectural Studies, Fashion, Industrial Design, Interactive and Visual Design, Interior Design or Urban Design Engineering). -The Queensland University of Technology is one of the universities interested in incorporating BIM education into its curricula through the adoption of integrated curricula based on digital design, integrated design, and the continuous annual update of its curricula and through a strong program for reviewing and modifying the objectives of the curricula.
	Units and hours	-The number of approved points for the academic program is 384 approved points that the student must pass in order to obtain a bachelor's degree. The number of points for courses that contain content of digital curricula and BIM technology is 216 approved points out of the total number of program hours.
	Its role in integrating BIM	There is a wide range of elective courses within many different specializations, from which the student chooses supplementary courses classified into many fields, namely: Animation - Architectural Studies - History of Art and Design - Creative and Professional Writing - Drama and Acting - Entertainment - Fashion Communications - Industrial Design Studies - Interactive and Visual Design - Interior Design Studies - Urban Design. In addition to these subjects, the college organizes group workshops on architectural design topics, including (such as the integrated design workshop using BIM - and the sustainable design workshop -.....) Besides field training, the college is very interested in providing practical training with major companies and design offices in the state, as it makes partnerships with them in various fields and topics, including practical training for students.

	Lab	-The college has a number of advanced and modern laboratories that help students raise their technical level, including: -The Institute of Traditional Studies: which includes laboratories and workshops for all engineering disciplines available at the university, such as the chemistry and food lab, advanced computer lab, and modeling workshops. -the cube : A state-of-the-art technical institute located in the Center for Science and Engineering, it enables a massive digital display of research results and initiatives as it integrates research thinking into an educational environment and creates an interactive space where innovation pulsates. -Institute for Future Environmental Studies: The institute works to study, analyze and predict global environmental changes. The institute has advanced research and analysis equipment, and it has satellite management for scientific research purposes. -Institute of Robotics and Advanced Mechanical Sciences: The institute contains advanced devices and equipment for designing and building modern models of robots, autonomous equipment and programming. The institute works with the participation of international partners around the world.

Table No.7 Building information modeling (BIM) applications in universities

A comparison between models from international universities in applying the relationship between university strategies and teaching strategies to integrate BIM systems into academic education							
Queensland University of Technology	Georgia Tech University	Liverpool University	Penn State University	Teaching strategies for integrating bim systems			
available	available	available	available		Locations for seminars and conferences	Financial support	University support
available	available	available	available		Physical equipment for the halls		
available	available	available	available		Platforms and websites		
					Organizing seminars and conferences	Moral support	
					Organizing training courses		

University strategies for integrating BIM systems

	Introduction to computer applications		-	advanced cad	Curricula and individual initiatives	Curriculum development	
			-	d ٣ visualization			
Building information modeling technology	ApplicationsBIM	Programming for civil engineers and architects	BIM course	Computer applications for professional skills	elementary education curricula		
	advanced applicationsBIM	Building information modeling theory, advanced applications and tools					
Architectural rendering and photography 1	Media Shows + Modeling 1		-	digital display			
Architectural rendering and photography 2	Media Shows + Modeling 2						
Architectural rendering and photography 3							
Architectural Design 1	Introduction to design and the built environment	the Environmental design 1	design studio ١	design studio	Interactive Curricula		
Architectural Design 2	design studio 1	the Environmental design2	design studio 2				
Architectural Design 3	design studio 2	the Environmental design3	design studio ٣				
Architectural Design 4	design studio 3		design studio ٤				
Architectural Design 5	design studio 4		design studio 5				

Architectural Design 6	design studio 5		design studio 6				
Architectural Design7	design studio 6		design studio 7				
Architectural Design8	design studio ٧		design studio 8				
			Visual Communicatio n1	visual communicati on			
			Visual Communicatio n 2				
			Technical Systems Integration				
environment al control systems	Ecosystems 1		Introduction to environmental control systems	Environment al Studies			
	Ecosystems 2		environmental control systems				
	Building materials and building construction	Structural engineering in the built environment 1	Building materials and building construction 1	construction technology			
	Structural structures 1	Structural engineering in the built environment 2	Architectural Construction Systems 1				
	Structural structures 2	Design of reinforced concrete and metal structures	Architectural Construction Systems 2				
			Building materials and building construction 2				
Architectural Techniques			-	digital graphic			

Integrated digital technologies				representation			
		Introduction to the digital built environment	urban studies	urban studies			
		construction management	Architectural Professional Practice	construction management			
		Civil and Architectural Engineering Projects		class projects	Multidisciplinary workshops		
		Group integrated design project					
		Architectural design project					
		individual project					
		multidisciplinary project					
				workshops			
				training	External training support		
		available			The stage of traditional conferences and seminars	Support for faculty members	
available	available	available	available		Medium-term training program stage		

1. Penn State University Bachelor of Architecture Program (United States of America).
The number of hours of the study program is 162 credit hours that the student must pass [1] , and the number of points for courses that contain content of digital curricula and BIM technology is 96 credit hours out of the total number of program points. That is, BIM technology is applied in a percentage of 59.2% of the total courses.

2. Liverpool University Bachelor of Architecture Study Program (United Kingdom). The number of academic program points is 510 approved points that the student must pass, and the number of points for courses that contain content of digital curricula and BIM technology is 277.5 approved points out of the total number of program points. That is, BIM technology is applied in 54.4% of the total courses.

3. Georgia Tech University Bachelor of Science program in Architecture (United States of America).

The number of academic program points is 510 approved points that the student must pass, and the number of points for courses that contain content of digital curricula and BIM technology is 277.5 approved points out of the total number of program points [1] . That is, BIM technology is applied in 58% of the total courses.

4. Queensland University of Technology to study a Bachelor of Architecture (Australia).

The number of approved points for the academic program is 384 approved points that the student must pass in order to obtain a bachelor's degree. The number of points for courses that contain content of digital curricula and BIM technology is 216 approved points out of the total number of program hours. That is, BIM technology is applied in 56.2% of the total courses.

5-Analytical study of the regulations for the environmental architecture engineering program at the Faculty of Engineering at Tanta University:

About the program:

-The Environmental Architecture Engineering Program is a specialized and distinguished program in the College of Engineering. The College obtained the official approval to start studying in the program by Ministerial Resolution No. (4842) on 9/24/2016 AD.

-Qualifies for a Bachelor of Engineering degree specializing in environmental architectural design and urban environmental design (credit-hours system), which is in line with the needs of the labor market, and keeps pace with modern trends in engineering and architectural sciences on the one hand, and complies with all requirements of quality and academic accreditation on the other hand.

-The student must complete 180 credit hours. At the first level, the student must pass 36 credit hours. After that, he begins studying basic engineering courses related to architecture, and design courses in environmental architecture. The student is then allowed to choose specific elective courses in order to enhance and improve the student's interest in a specific topic or topics.

-Number of study and research laboratories/workshops allocated to the program: 11chemistry lab-physics lab -Material Properties Lab-Soil Mechanics and Foundations Lab-Survey Lab (Public Works)-fluid mechanics lab-reinforced concrete plant-environment Lab-Production engineering-workshops-language lab.

Figure 7: Environmental Studies Laboratory, in Environmental Architecture Program

-The first step: Supporting Tanta University:

Table No.8: Supporting Tanta University

Supporting Tanta University		
Financial support	Locations for seminars and conferences	There are several conference rooms at Tanta University (conference hall in the university administration building - conference hall in the medical complex - conference hall in the colleges complex in Sberbay area).
	Physical equipment for the halls	The halls are equipped with equipment, internet connections and screens.
	Platforms and websites	Tanta University occupies the second place for electronic services at the level of Egyptian universities.
Moral support	Organizing seminars and conferences	Tanta University is working on organizing several local and international annual conferences. Topics related to building information modeling can be included in the university's annual conferences schedule.
	Organizing training courses	The university has a faculty development center. Training topics for building information modeling can be included in the training schedule.

The second step: studying the relationship between the levels of knowledge of building information modeling and the independent courses in the list:

By reviewing the description of the courses of the Environmental Architecture Program, we find that there are four computer courses that represent the independent courses in the list, which are only eight credit hours, or only 4% of the total number of program hours, which is a very weak percentage and is represented in the following table:

Table No.9: the relationship between the levels of knowledge of building information modeling and the independent courses

Cognitive levels of building information modeling skills course	**Skills**	**Course**
First level	2D computer software	Computer applications 1
Second Level	Binoculars and 3D stereoscopic	Computer applications 2
Third level	Sustainability and simulation programs	Computer modeling and sustainable analysis
Fourth level	Determine implementation time and cost	Building Technology Configuration BIM

The third step: Studying the relationship between building information modeling knowledge levels and the complementary courses in the list:

By reviewing the description of the courses of the Environmental Architecture Program, we find that there are a number of integrative courses, which are only 54 credit hours, or only 30% of the total number of program hours, and they are represented in the following table:

Table No.10: relationship between building information modeling knowledge levels and the complementary courses

Cognitive levels of building information modeling skills course	Skills	Course
First level	2D computer software	Environmental Architectural Design 1 Environmental Architectural Design 2 Architectural Construction 1 Architectural Construction 2
Second Level	Binoculars and 3D stereoscopic	Environmental Architectural Design 3 Architectural construction and executive design principles Architectural models and models Architectural expressions Shadow and perspective
Third level	Sustainability and simulation programs	Environmental Architectural Design 4 Environmental Architectural Design 5 Environmental Lab Design 6 Environmental control Ecological buildings Achieving green architecture Rationalization of energy consumption indoor environment qualit
Fourth level	Determine implementation time and cost	-

The fourth step: studying the relationship between the cognitive levels of building information modeling and the university and college strategies for integrating the BIM:

-By studying the university and college strategies for integrating BIM, it is clear that we can add a fifth level of building information modeling knowledge for multidisciplinary workshops and support for external training to add to students' skills (Management of executive yards, operation and maintenance, which is one of the features of BIM) through integrative decisions in the regulation represented in (technical and sanitary installations - building economics - air conditioning and cooling of buildings - basics of management - interior design). We can also prepare and equip integrated design studios as shown in the following figure:

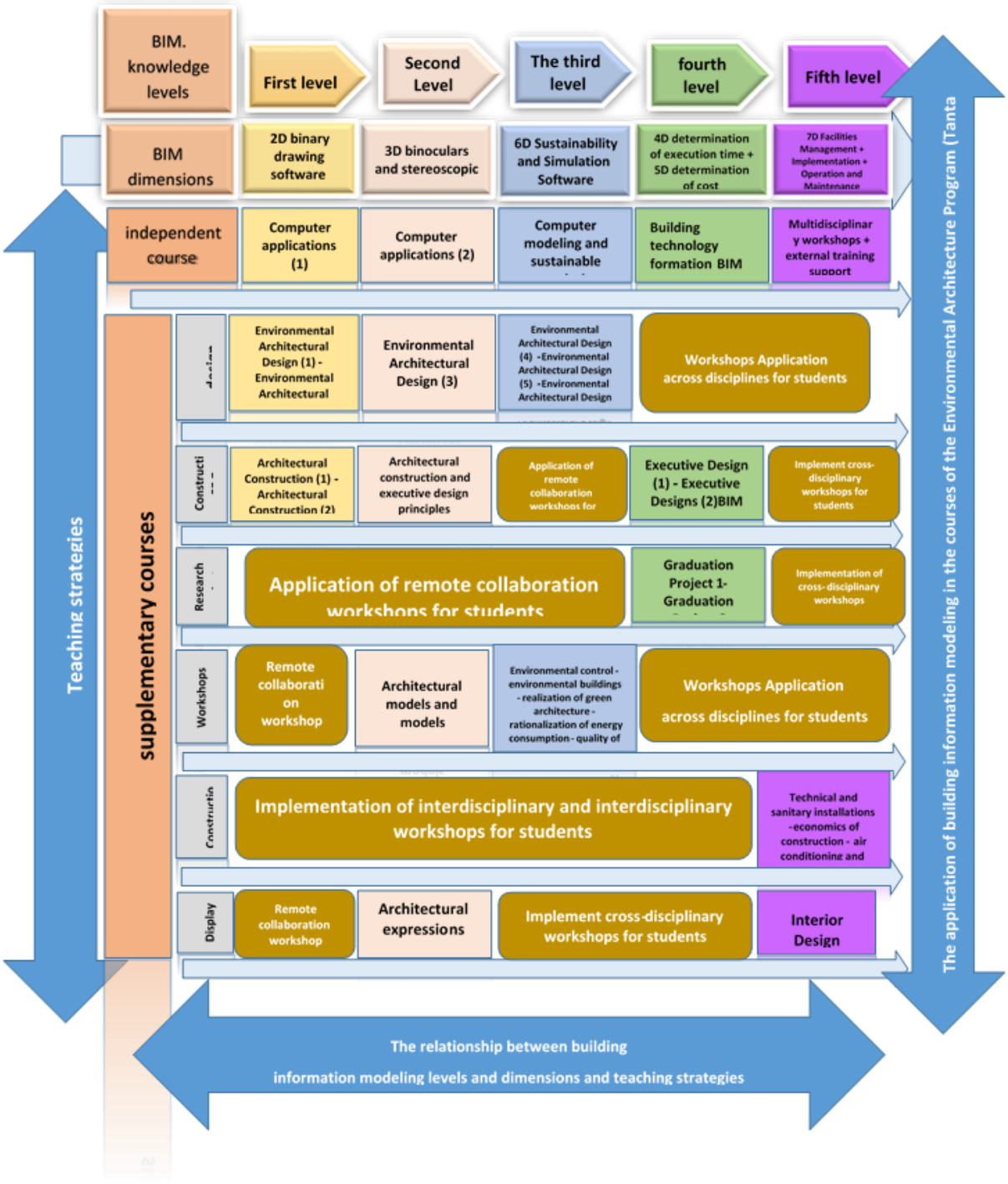


Figure 8: The effect of the relationship between building information modeling levels and dimensions and teaching strategies

Environmental Architecture Program:

The number of hours of the academic program is 180 credit hours that the student must pass, and the number of points for courses that contain content of digital curricula and BIM technology is 62 credit hours out of the total number of program points. That is, BIM technology is applied at a rate of 34% of the total courses, and when the proposal is applied by research, the number of hours during which BIM is applied will increase to about 87 hours, i.e. the percentage will increase to 48%.

6-The proposed methodology for integrating modern BIM systems into the academic field

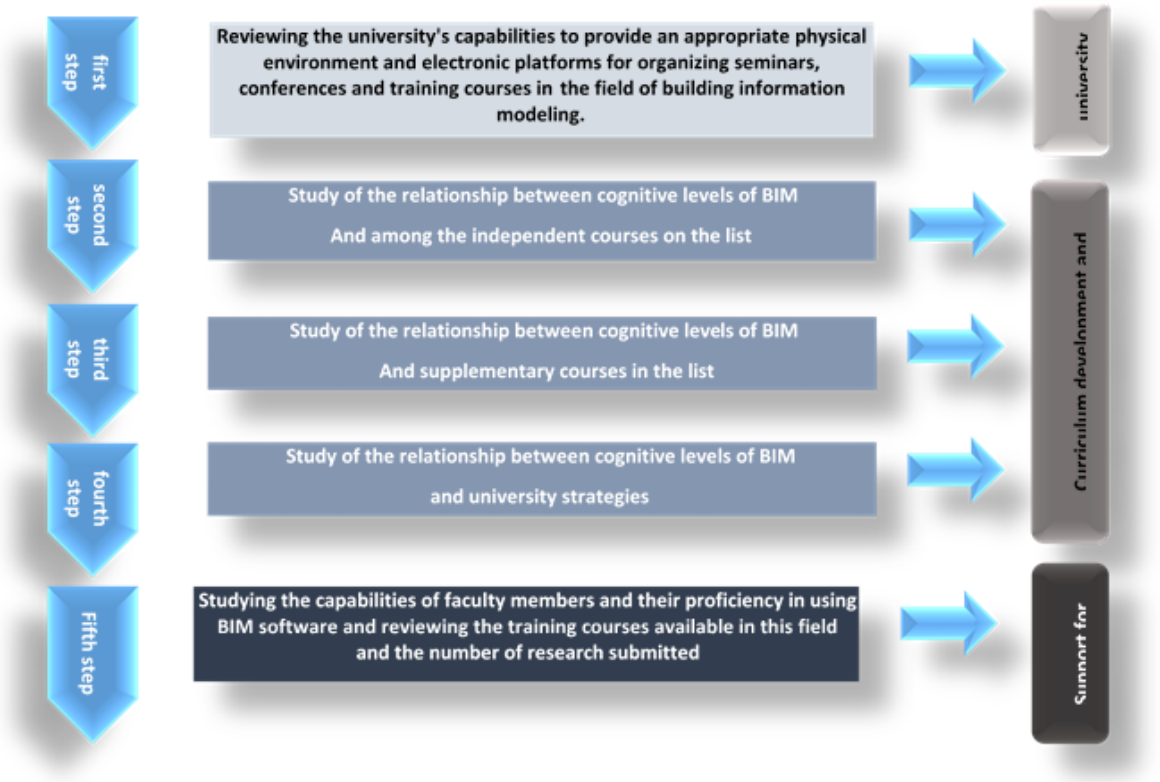


Figure 9: proposed methodology for integrating modern BIM systems into the academic field

7-Results:

By analyzing the strengths and weaknesses of the study of integrating Building Information Modeling into the Environmental Architecture Program Regulations

	Strength point	Weak points
University support	Availability of the appropriate physical environment of conference rooms equipped to hold conferences and seminars. Experience in organizing conferences. Equipped training centers. Availability of technical support for platforms and websites.	Lack of topics and conferences focusing on Building Information Modeling technology.

Academic Curriculum Development	The existence of independent courses in the list that meet the knowledge levels of building information modeling. Existence of integrative courses that achieve a good level of application of building information modeling knowledge levels.	The percentage of hours in which the knowledge levels of building information modeling are applied is still lower than the percentages in foreign universities. The lack of application by contracting companies and design offices to BIM programs, so the student cannot rely on external training. Lack of seminars in the field of building information modeling.
teaching staff	The university encourages faculty members to attend practical conferences and international publication in the field of building information modeling.	There is no support for faculty members to obtain training courses in the field of Building Information Modeling, despite its importance and high cost. There are no serious steps to provide training within the university institutions.

8-Recommendations:

-The university's inclusion of building information modeling in the schedule of annual conferences held at Tanta University.

-Encouraging external research centers to work inside the university.

-Encouraging the organization of independent courses from private training centers to familiarize themselves with the BIM system.

-Integrating BIM into the traditional academic curricula.

-Preparing training programs for students.

-When applying the new regulation 2022-2023, in which the number of program hours will reach 160 credit hours, the student must pass it. The number of points for courses that contain content of digital curricula and BIM technology is 87 credit hours out of the total number of program points. That is, the BIM technology is applied at a rate of 54% of the total courses, and thus it will match the international averages in the application.

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