Prototype of Building Information Modeling (BIM) Framework to Development the Architectural Curriculum in Egypt

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Abstract— Building Information Modeling (BIM) technology is one the most modern technologies being used in the world in the field of architecture and construction industry. BIM technology helps architects and engineers to reduce the number of mistakes during and after the process of design and construction. Being a new architectural concept and an innovative way of design it helps to make drawings, modeling, simulation and all sustainable calculation more easily, in comparison with traditional steps. Later architects and engineers understood that there is a gap between education systems and the requirements for graduates.

A lot of researches were conducted by architects who were working alongside higher education institutions in order to create a roadmap that enables universities to include BIM in the curriculum. The process started with individual efforts to integrate BIM into curricula within standalone courses or studio design, later there appeared an idea to create integration systems using BIM technology in architectural curriculum.

This article exposes an overview of the efforts taken to integrate BIM technology in the architectural curriculum and proposes a pilot framework for using BIM technology in architectural education system in Egypt at the undergraduate level.

Keywords — BIM, Building Information Modeling, architectural education in Egypt, architectural curriculum, IMAC, BAF.

1 Introduction

Including BIM technology in the architectural curriculum in Egypt cannot be in one step, we have to understand and analyze the previous efforts that were taken in other countries and opened some questions like how we can develop the architectural curriculum to upgrade the obsolete education system in Egypt or simulate the new world systems that are already based on the use of BIM technology.

2 Procedure for Paper Submission Current situation with the architectural curriculum in Egypt

2.1 Review Stage

A lot of Egyptian architects started to call for the development of the architecture department long ago, this problem was discussed in a great number of researches and articles, so this idea is not new. However new technologies appear every day and we face this problem again and again. It becomes clear that we have to reach the sustainability of architectural education. Many Egyptian professors and famous architects are calling for the development of the education system to match the world's level. Among them [1] is Dr. Kamal Riad who says that there is a mismatch between the education curricula in the schools of architecture and the fact after graduation, and it can be explained by several reasons. Firstly, there is no development of education curricula and that's why it does not match the time. Secondly, education programs are weak in practical training and do not provide an adequate opportunity for teachers to keep pace with the time, such as taking part in seminars, conferences, negotiations. Another opinion belongs to Dr. Ezzat Saeed who says that the problem of architectural education in Egypt is at the level of compatibility between the curriculum in architectural departments and working life.

There is no balance between the product and the process. This idea is discussed in the article by Professor Yasser Mahjob [2] who recommends using computer technologies in the architecture field. According to his words the technology is a new tool entering the sphere of architecture; nowadays all fields depend on the information technology and computers. The computer is not only a new tool added to the traditional ones, it also changes the way we draw, design, see information, manage projects, it makes us working more effectively.

2.2 Questions and aims

The aim of this paper is to find answers to some important questions which will influence the BIM process. We really need to improve the architectural curriculum in Egypt as it is the main requirement for the integration process. It is also important to study the previous experience of BIM integration in the sphere of education. Having answered these questions we

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can propose a new education system based on the use of BIM technology.

3 The need of BIM integration to the academic curriculum

BIM changes the way architects think and design [3]. In the last several years the use of this technology has grown in the architecture, engineering and construction (AEC) industry and sustainability [4]. It was realized that BIM education in university curricula is an important requirement for satisfying educational adaptation in real work in the architecture industry [5]. It is believed that BIM in academia is the fastest way to fill the gap between the education and real work and accelerate BIM knowledge and skills [6]. Table 1 shows levels of BIM importance for the curriculum.

It is a general believe that the fundamental education has to cover the lack of BIM-skilled professionals to fill the gap between BIM and the architecture industry [7].

3.1 The international situation. BIM integration to curriculum in USA and UK

TABLE 1

IMPORTANCE OF BIM FOR THE FUTURE OF AEC

	Very Important	Important	Neutral	Unimportant	Very Unimportant
Arch.	72%	28%	0%	0%	0%
Eng.	67%	29%	5%	0%	0%
CM	70%	22%	4%	4%	0%

From the early 90s Georgia Institute of Technology in USA has started to make some researches in BIM and from 2000 – to teach BIM as technology. In 2004 some standalone courses were organized and in 2006 some universities began to combine construction management and integrated design studio courses in an experimental way. In 2008 BIM was applied in design studio [8].

In UK the situation was different. The introduction of using BIM in academia started because the government realized that it is BIM technology that has a great effect on the AEC industry, but there is no BIM experience in academia [9]. In the beginning some individual separated courses were created. They introduced BIM both in skill and knowledge levels. After this UK universities developed a system covering BIM in academia (BIM Academic Forum – BIM Academic Framework) and making its full integration with curricula. In our paper this UK system will be compared with the systems worked out in other countries.

However, teaching and integrating BIM to the curriculum is not as simple as introducing the application within a module or some of academic programs. BIM must be a part of all courses in the architecture curriculum and be distributed through all education levels.

According to Chistenson [10], “The act of creating a parametric building model in Autodesk Revit, as BIM application, requires that a designer or architect must be able to intelligently define relationships between and within building elements which he will use in the model”. And it’s impossible if we don’t have an integration system between all courses. Chistenson also speaks about BIM users and spatial case in Revit: “The successful user of Revit, in addition to understanding how the software works, must understand the construction technology sufficiently well in order to intelligently define such relationships”. The growing number of architectural engineering courses in AEC education demand for specialists having both conceptual and practical skills.

So, Chistenson considers that a good modeler (a person who makes modeling) must have the basic knowledge of building, construction and details of elements in order to understand the relationship between the elements in the programs which he will use to make a model. It has been proved that BIM is not only skills or a program to fix problems, it is also a cycle of knowledge required to be obtained before starting to use BIM.

3.2 ARCHITECTURE SKILLS REQUIRED FOR LEARNING BIM AND THE ADDITION PROGRAMS

There is a question whether a student must or need to learn manual engineering and computer aided design (CAD) drawing (2D and 3D) of building elements before mastering BIM. Some researchers like McLaren [11] find that learning manual drawing using CAD system enhances students knowledge and skills which they need for creative design (quality of design) and appreciating drawing conventions and standards (quality of drawings).

Some studies suggest that learning 2D and 3D CAD is not important or essential for BIM education and skills, though learning manual engineering drawing and fundamentals of BIM is still required. These studies report that students will not need CAD once they learn to utilize BIM tools, and the use of BIM would increase to eventually replace CAD [12], so we don’t need CAD programs.

According to Sacks and Barak (2010) [13], students with CAD experience have problems in learning BIM tools, because they expect that processes, commands and workflows in BIM are similar to those of CAD tools, but in fact they are different. Changing the software workflow takes much time if you are already got used to a certain kind of software. In concept BIM is smarter than the CAD way to make drawing, so students should appreciate BIM more than traditional CAD [14]. The right way of applying BIM doesn’t depend on CAD methods.

However some other studies say that learning manual sketching, reading and understanding drawings, working with physical models and learning CAD are prerequisites for learning [15], because students must understand the details of construction and architecture modeling. To have a good model one should understand connections between the elements.

So, the main goal from using CAD is learning technical drawing in order to improve the user’s BIM skills. The way students learn this is not so important. But they must learn the technique of drawing building elements, possess accuracy, must be able to calculate costs and sustainability. BIM is not limited in creating lines, geometries; it requires a deep understanding of building constructions and connections between every component. Students must have training or experience in working with some building under construction to improve their skills.

3.3 The right time to integrate BIM to curriculum

In addition to the status of BIM in AEC courses, the courses and knowledge of BIM are more required at undergraduate and postgraduate levels, because it is important to make integration in line with the needs of AEC industry in real life in order to achieve the desired efficiency and performance. The question about the right time to start teaching BIM is critical for AEC programs.

For answering this question we can take the study of Burcin Becerik-Gerber [16] who finds that most of the programs are required at the undergraduate level – freshman 5%, sophomore 25%, junior 38% and senior 55% - and 55% of BIM programs can be integrated at the master's level. It is suggested to integrate BIM at the early stages of AEC degree programs (Fig. 1).

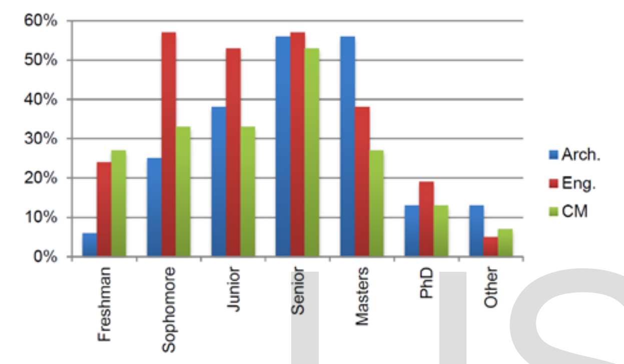

Fig. 1. The time required to integrate BIM to architectural curriculum

So, the study proves that it's better to integrate BIM at the undergraduate level than at the postgraduate one as students will support the knowledge in BIM by some of projects and training they get at this level under control of an academic supervisor. So having finished this academic level they will be able to work in real projects without any problems. And of course it's necessary to integrate BIM at the postgraduate level in order to develop the BIM research sphere.

We must also remember about the right distribution of BIM courses. The courses must be connected with all academic levels, besides we should clearly imagine their value and the amount of knowledge they provide.

4 Forms of BIM framework in architectural education in the world

4.1 BIM Academic Forum – BIM Academic Framework, UK

The BIM Academic Forum (BAF) is a group of representatives from a large number of UK universities formed to promote the academic aspects of BIM. They have been working on developing a BIM academic framework. The purpose of the academic framework is a roadmap towards a longer term vision of incorporating BIM learning at the appropriate undergraduate and postgraduate levels that facilitates the development of professional skills with the relevant BIM knowledge. It is considered necessary to develop a skill capability/competence matrix and establish consistent and comprehensive BIM-related learning outcomes at various levels of undergraduate and postgraduate discipline-specific programs. For this purpose the suggested framework is divided into 3 levels which are equal with the number of academic years. This is shown in Table 2 that represents the learning outcomes from the workshop group sessions [17]:

TABLE 2
BIM Academic Forum Framework at the undergraduate level

Level	Knowledge and understanding	Practical skills	Transferable skills
4	- importance of collaboration - the business of BIM	- introduction to technology used across disciplines	- BIM as a process/technology/ people/policy
5	- BIM concepts – construction processes - stakeholders' business drivers - supply chain integration	- use of visual representations - BIM tools and applications - attributes of a BIM system	- value, lifecycle and sustainability - "software as service" platforms for projects - collaborative working - communication within inter-disciplinary teams
6	- BIM across the disciplines - contractual and legal frameworks/regulation - people/change management	Technical knows-how: - structures and materials - sustainability	Process/management: - how to deliver projects using BIM - information and data flows - BIM protocols/EIR

Table 2 shows that the roadmap is divided into 3 levels. And David Cracknell (the BFA report, initial BIM learning outcomes framework) says that BIM learning must link AEC industry with academic levels by three stages – strategic, management and technical. In this case we can make some analysis:

According to the BIM Academic Forum, Level 4 is the first year of the undergraduate academic level. At this stage students must understand the BIM concept and its importance to AEC industry, the technology and the way its use helps across disciplines. This level can be called "concept" or "fundamental" in BIM knowledge.

Level 5 is the second year of the academic level. It is supposed to be a high level of BIM knowledge. Students must understand the role of BIM in construction processes, supply chain integration and must be able to use BIM software programs and modeling tools to create models and visualization. This level also provides the knowledge of sustainability and BIM management in teamwork. This level can be called "BIM software skills".

Level 6 is the third and the last year of the academic level. It is also a high level in BIM learning. Students must be able to calculate the sustainability effects, must be ready for management work on large scale projects as well as to deliver projects using BIM (IPD). This level can be called "BIM technical support".

The BAF framework does not cover only undergraduate levels. It also includes a roadmap to postgraduate levels as it's

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shown in Table 3:

TABLE 3
BIM Academic Forum Framework at the postgraduate level

Level	Knowledge and understanding	Practical skills	Transferable skills
7	1- collaborative working, BIM, information management and its application in the built environment 2 - commercial implications contractual/legal etc. 3- de-risking projects through BIM and risk management 4- understanding the nature of current industry practice 5 - client value – soft landings 6 - business value – RoI/ value proposition 7- understanding of the supply chain management 8- lifecycle management of BIM – asset, performance in use etc.	1- demonstrate ability to adopt different platforms 2- critically judge/evaluate various BIM tools/applications 3- protocols/inter-operability/ standards 4- capability evaluation 5- change in the way projects are to be delivered 6- visualization of large data sets 7- learn principles and links to BIM 8- use of BIM enabled technology e.g. palm devices	1- project level application 2- cross discipline and team working 3- importance of effective communication and decision making – human interactions! 4- process mapping and BPR 5- change management and cultural gap 6- masters level thinking – strategic/technical/ managerial 7- ability to assess barriers to BIM at various levels e.g. corporate/project

The BIM academic framework is also proposed for the postgraduate level. Some UK universities like Liverpool [18] suggest a full-time program for the level of master degree in BIM. The first year is devoted to BIM theory and the second year – to the thesis (Dissertation, Design by Research or Design). Such programs are made for students or practitioners from architecture, engineering or construction professions. They help to develop BIM skills in theory and practice in design and construction and to prepare experts in the field of BIM. The concept of this framework consists in preparing freshman students to have knowledge and skills at the undergraduate level and to create experts in BIM knowledge.

4.2 IMAC Framework, Australia

This framework is worked out by Jennifer A. MacDonald and it is very simple. Sydney University of Technology decided to explore methods of upgrading and improving in BIM, collaborative design education system between students of AEC disciplines, with the aid of BIM tools [19].

The transformation from working with traditional systems (CAD, 3D MAX etc.) to BIM technology is not only a shift in programs or software as it was said before. It is also necessary to change the way of design and construction in teamwork. BIM requires a new format of working. It implies the shift from individual work to work in groups, information sharing, collaboration and integrated project delivery [20]. And these new aspects, of course, should reflect on the architectural curriculum.

The current shortage of design professionals trained in BIM remains a barrier to universal adoption of collaborative working practices in the industry. Just as industry must undergo a paradigm shift from its old combative culture to one of integration and information sharing, so must "academia" [21]. And there was a step undertaken in this direction. So the IMAC Framework was proposed (Figure 2). It is a draft proposal made by MacDonald with the help of an ALTC (Australian Learning and Teaching Council) grant. It is necessary to underline that this framework is not linked to academic levels. MacDonald suggests that every university has freedom how and when to integrate BIM system to the curriculum according to students' knowledge in every step:

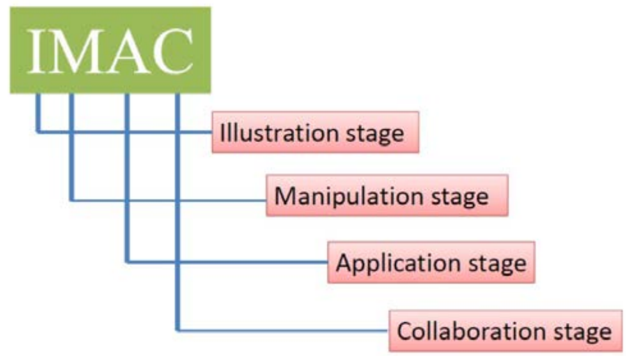

Fig. 2. The IMAC Framework

The IMAC BIM Framework is designed to help educators benchmark their courses in order to improve collaborative design within AEC-ES.

The IMAC stages – Illustration, Manipulation, Application and Collaboration – are worked out according to the levels of the taxonomy of learning proposed by Bloom et al (1956) (Figure 3) [22].

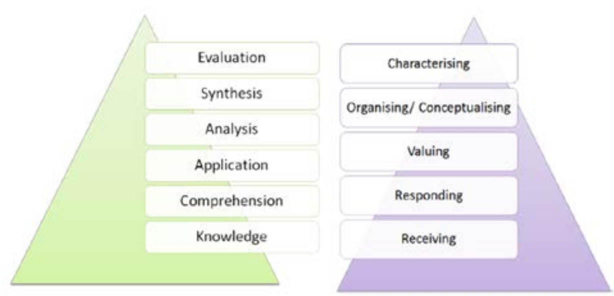

Fig. 3. Bloom's Taxonomy of Learning: Cognitive Domain (left) and Affective Domain (right)

Bloom's taxonomy is divided into three domains: cognitive, affective and psychomotor. Bloom's taxonomy [23] is a chart to promote higher forms of thinking in education, such as analyzing and evaluating concepts, processes, procedures and principles, rather than just remembering facts (rote learning). It is most often used when designing educational, training and learning processes. Figure 4 shows the relationship between Bloom's taxonomy and the IMAC system:

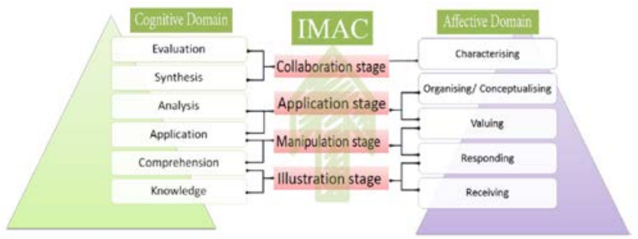

Fig. 4. The four stages of BIM framework linked with Bloom's taxonomy

The four stages of the IMAC Framework are described in detail below:

1- Illustration Stage (Knowledge/Comprehension and Receiving/Responding):
This is a knowledge step in BIM technology. Students must understand what BIM means, understand the details of building connections and how buildings are contracted. It will help students to understand buildings lifecycle. This will also reflect on the quality of modeling at advanced levels.

2- Manipulation Stage (Comprehension/Application and Responding/Valuing):
This step is more advanced in BIM knowledge. Students start to use BIM applications and tools, make simple models and some small edits, develop skills of working in teams and basic IT literacy skills, in addition to developing discipline-specific knowledge.

3- Application Stage (Application/Analysis and Valuing/Organizing):
This step is considered to be an advanced one. Students have a good experience in architecture science and in using BIM tools. They must improve to a more advanced step in modeling and learn how to set models up for an effective interdisciplinary collaboration. Students also start to utilize tools to analyze models using exports from Building Information Models. Construction managers should develop 4D and 5D schedules and plan logistics and materials ordering using models from other disciplines, principles of value engineering and sustainable design. It is also necessary to determine how BIM tools can be used to assist this.

4- Collaboration Stage (Synthesis/Evaluation and Characterizing):
This step implies inter-disciplinary collaborative work on joint projects. Working groups should consist of students from each AEC discipline. Students learn more about the types of contracts, and this facilitates collaborative work and the use of BIM. Teachers must give students real-world problems to solve.
Even though this framework was worked out in Australia, due to a great positive point it does not have specific aspects of the country. That's why it can be suitable for implementing in any other education system.
Moreover, this framework is flexible and can be applied in the development of curricula or even mapped into a single course module.

4.3 The differences between BAF and IMAC systems

Both of these systems are roadmaps to integrate BIM in the architecture curriculum. But they have a different perspective. The BAF system's steps are linked with 3 levels of the architecture learning system in UK. The IMAC system does not coincide with academic levels. It is a general concept about methodology and integration ideas. The IMAC system gives universities an opportunity to choose how and when they can integrate BIM to academic levels. So, it is more flexible than the BAF system.

5 BIM initial framework in Egypt:

The main BIM concept consists in making integration between some aspects which are to be combined. It is also necessary to provide a consecutive learning process. Within BIM integration a number of interactions are carried out in multiple stages between several different fields. However these fields are common in some points. The architectural education in Egypt includes a range of separation courses. Some courses have common points, but in order to get the target in BIM concept they need to be integrated in one.

This concept will be applied in curriculum within a new BIM initial framework in four stages as it is shown in Figure 5:

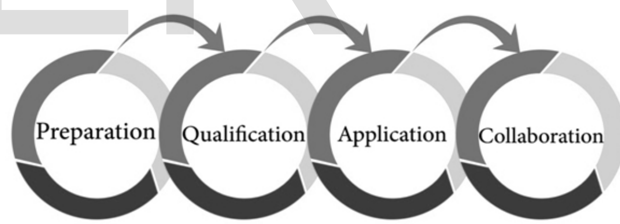

Fig. 5. Initial concept of BIM in architecture education

1- Preparation: at this stage students must understand the concept of BIM technology and the benefits of using BIM system. Students also should develop every year on their own to get new tools and qualification to next stages.

2- Qualification: students must be able to use the tools of BIM software to understand how these tools work before utilizing them in projects.

3- Application: at this stage students should utilize BIM tools in projects to understand the principles of their work. Students also start getting advanced BIM tools in sharing information and module between architects working on one project.

4- Collaboration: students master in using BIM technology and

obtain skills in sharing information and collaborating with other project's fields. In this way they are trained to work on real projects.
It is necessary to understand that BIM learning plan will effect on the three main aspects as it is shown in Figure 6:

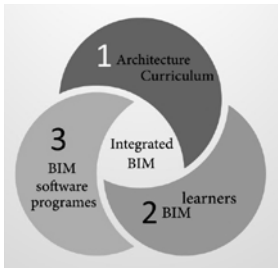

Fig. 6. BIM learning plan integration

So, the main concept implies making a full BIM system in four stages (Preparation, Qualification, Application, and Collaboration) by changing or adding some subjects to the curriculum. It is necessary to apply one of BIM software in projects. Both students and instructors take part in improving the BIM learners' skills. Instructors teach BIM applications or are included in the teaching staff in lectures.

4.1 BIM LEARNING CONCEPT DISTRIBUTION (BIM FRAMEWORK)

As discussed above, the undergraduate level is the right time for BIM integration with AEC disciplines in curriculum because in this case students will support their knowledge in BIM by working on some projects under control of an academic supervisor. So having finished the academic level they will be able to workon real projects without any problems.
The architectural curriculum in Egypt includes 5 years: one preparation year and four years in architecture. So the link between the initial concept of BIM framework and the curriculum is shown in Figure 7:

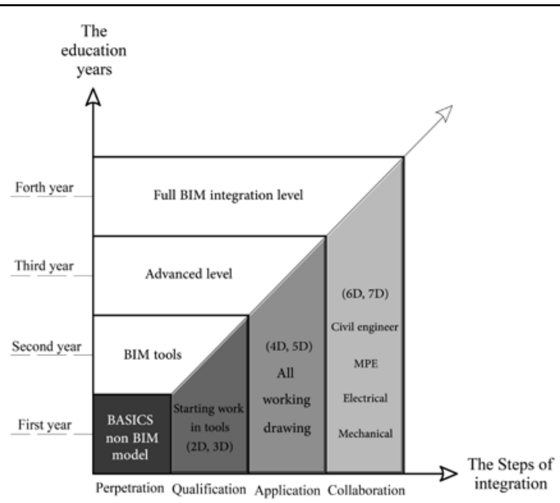

Fig. 7. BIM framework in architectural education, undergraduate level

This framework will be a prototype to make BIM integration with education in Egypt. It is an initial plan which will be applied to the architectural curriculum. The prototype will cover two principles at the same time as it is shown in Figure 8:

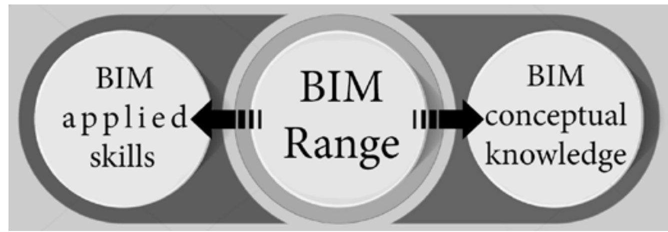

Fig. 8. BIM range learning cover

The initial BIM concept in architectural education will be integrated within the Undergraduate BIM framework in order to create a BIM learning curve. Figure 9 shows the way BIM process is distributed on the curriculum according to the education system in Egypt:

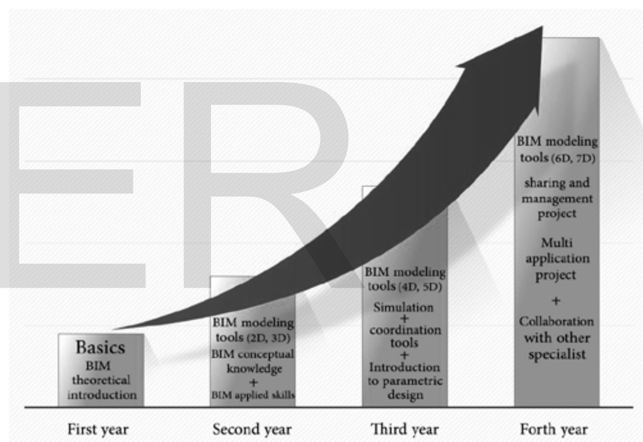

Fig. 9. BIM learning curve in Egypt

5.2 BIM framework distribution on academic levels:

In this point we will show the details of BIM framework distribution on academic levels. But before this it is necessary to explain what the preparation year means.
Preparation year:
It is the first academic year at university. This year is divided into two semesters during which students attend some courses. They include foundation science courses (Mathematics 1, Mathematics 2, Physics 1, Physics 2, Chemistry and Mechanics) and theoretical courses (English, Human needs and Introduction to Engineering Materials, Introduction to Computer Science, Technical Drawing and Projection). After this year comes a specialist stage (Architecture, Civil Engineering, Mechanics, and Communications). A student's transfer to this stage depends on his marks and rating during the preparation

year, and sometimes, if students intend to enter the architecture department, they have to be tested in drawing and imagination.

How we can include this year into BIM education? It is not a simple task as this is a general year and we can't omit or change some disciplines, for example, courses in Materials. However such courses may help students in an indirect way. Students can learn about behavior of the materials which they use in design or construction. And this is also one of BIM tasks. Such knowledge and skills will be useful at the application stage when students start making simulation or utilizing costs tools in BIM.

In the other side, the course in Technical Drawing and Projection is an introduction to the architectural drawing principles. This course helps students to understand the principles of technical drawing. We can consider this course as a preparation stage for Architectural Drawing courses in the first academic year. Manual Drawing helps students to understand the connection between elements as well as improve skills in imagination.

First educational year in architecture (non BIM models, Preparation to BIM stage):

Preparation: this year is the illustration and preparation stage to the architecture science. Students must understand and train on the principles of design and architecture theory manually, they also should learn about building lifecycle. This knowledge and skills will reflect on the quality of modeling in BIM.

BIM technology is not for design, it is for smart modeling. The quality of a product depends on the users' skills, so it is necessary to enhance architectural skills before starting to use any computer tool (according to Point 2.2). Students don't need to learn using the CAD system or any other computer tool because it may have a bad effect on their skill in BIM technology. When students get used to the CAD system and expect that the BIM one is same, it takes much time to master another system. The process becomes difficult, there appear errors and conflicts. Utilizing computer tools at this level may kill the creative side of students' skills [24] in design process and imagination [25].

Students must learn the principles of architectural drawing such as diminutions and building elements. They should be able to draw these details and connections between building elements by hand. At this stage students start to gain knowledge of material names and properties and learn the way technology influences the architecture field and projects. The stage also implies theoretical introduction to BIM technology.

Second year in architecture, 2D and 3D BIM modeling tools (Preparation and Qualification stages):

Since this stage students are working in two aspects – within a preparation stage for mastering new BIM tools and learning more theoretical information about BIM in order to enhance skills in utilizing BIM tools in general (BIM conceptual knowledge and BIM applied skills).

Preparation: at this stage students must understand the difference between the non BIM and BIM model in theoretical and practical aspects and start using the main tools in 2D-drawing and 3D-creation. After this they learn to edit small and basic elements of buildings (the knowledge they got within courses in Building and Construction). The stage consists of standalone courses and is divided into two phases, theoretical and practical. The curriculum should also cover the principles of environmental design. This will help students to use simulation tools of BIM software at the application stage.

Qualification: this stage contains standalone courses. Within studio design students should model and present one full small project, utilizing BIM modeling tools and materials. At the end of the second year they make a simple render to one project (2D, 3D). This stage prepares students for working on larger projects using 4D and 5D design tools.

Third year in architecture, 4D and 5D in BIM (Preparation, Qualification and Application):

Preparation: at this stage students learn to understand 4D and 5D concepts of BIM within standalone courses. They master utilizing simulation and coordination tools and one of simulation programs like Ecotect. The stage also implies an introduction to parametric design using BIM technology.

Qualification: at this stage students must understand the theoretical methods of simulation (4D) in BIM standalone courses and their application in one small scale project using real sun path and location. They also must be able to imagine its effect on design. At this stage students get training in coordination concept (5D) to project's elements. They should understand its influence on the costs and quality of the project and materials. The stage implies working on one project in teams. Students learn to organize work in one central file.

Application: at this stage students should make a full project using 2D, 3D, 4D, 5D BIM tools in one project as application to cover all the previous studying. They also learn to create full working drawing details and documentation needs to the project using BIM tools within working in drawing studio (medium scale projects like plans, sections, elevations, air-condition ducts, firefighting pipes and electrical connections).

Forth year in architecture, 6D and 7D in BIM (Preparation, Qualification, Application and Collaboration):

Preparation: at this stage students must understand the concept of sharing and management project files between architects in a team. They learn to make a collaborative design using BIM that improves the quality of projects. The stage implies inter-disciplinary work within one project (for example, mechanical and civil engineering). Students are trained to organize their work in inter-disciplinary groups.

Qualification: students must learn BIM by sharing files and tools between other specialists in the project. They should be able to utilize coordination and management tools and reduce the number of conflicts in a project. Students learn to solve conflicts between disciplines, report issues, understand contracts and link a model with its data.

Application: students must be able to create all documents and tables for project details and calculate the project costs by using one of BIM applications. They should know how to estimate the time of working process at construction levels through working drawing studios.

Collaboration: the stage implies working in inter-disciplinary groups of architects in one large scale project (like civil engineer, MPE, electrical and mechanical engineers). It is a full application of all BIM courses within the academic program. It is necessary to make this application in real projects with real contractors and under university supervision. We must be sure that students will be well-qualified to work on real projects after graduation.

6 Conclusion

BIM integration with the architectural curriculum in Egypt will take four steps. Every step will have a level of integration value. This will reflect on students' skills at every stage. Students should understand BIM technology in theoretical and practical aspects.
Transformation of the obsolete architecture education system in Egypt will provide students with a good position in the learning value. It will allow them to become international architects and will give a chance to work in any international organization applying BIM technology.
BIM technology will help students to deliver projects at undergraduate and postgraduate levels faster and easier as well as to reduce the amount of mistakes at the level of design and construction. Moreover, this will have a positive effect on the economic situation in Egypt.

7 Recommendations

Building information modeling is thought to be one of the most important technologies in the architecture field. So, this paper recommends taking into account the integration process between BIM and the industry, for example, the way we can transform the system work in all companies in Egypt. Now there are some national projects, and we find it necessary to focus on using BIM while delivering them. It will have a positive effect on the Egyptian economy that was stalled in the last several years due to the lack of resources and money.
In the other side, this paper is focused on the BIM framework at the undergraduate level. As for the postgraduate level, our framework suggests to initiate more theses in the sphere of BIM. For example, master degree and PhD in BIM may help to increase the quality of the framework's results. It is also necessary to add more details or dimensions to this framework. The technology is flourishing every day, and in this case we must think of a current framework that will cover all latest changes in the field. The suggested framework relates to other disciplines as well. It is highly important to start developing courses in BIM that can be integrated with architecture sciences and allow to work with real projects after graduation. BIM is not only for architects, it is linked to all fields of building engineering, including architecture engineering as well.

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