Ain Shams University
Faculty of Engineering
Department of Architecture

Architectural Education and Simulation

Methodology for Implementing Academic Games as an Educational Tool in Architectural Education

A Thesis submitted in Partial Fulfillment
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Statement

This dissertation is submitted to Ain Shams University – Faculty of Engineering – Architectural department for the degree of Ph.D. in Architecture.

The work included in this thesis was carried out by the author in the department of Architecture – Faculty of Engineering - Ain Shams University, from September 2004 to September 2007.

No part of the thesis has been submitted for a degree or a qualification at any other university or institute.

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Abstract

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Title: Architectural Education and Simulation Methodology for Implementing Academic Games as an Educational Tool in Architectural Education

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Experiential learning theories and active teaching models are the most contemporary demand specially in case of teaching applied sciences. Many voices call for using this approach for teaching architecture as it provides many advantages and fixes many of the contemporary architectural education deficiencies. Many factors obstruct the availability of using such approach in our local communities. Lack of time and resources, implications of mistakes and domination of the dated teaching strategies are only a few of these obstructions. One of the solutions figured to solve this problem, is the use of the modern digital technology.

Based on the progress and offers that the contemporary digital technology has achieved, many educators viewed simulators, digital training models and games as educational tools. Digital games are among those tools used widely in many fields to train and teach users different certain fields.

The goal of this thesis is to investigate the availability of using computer games as educational tools in the architectural education, to what extent these can fulfill the needs of architectural education based on the experiential learning approach. A conceptual framework has been developed as the present study reaches the closing chapter. This game may be used as an educational tool for teaching the "Building Construction I" course to first year architectural students.

Keywords: Edutainment, Digital Games, Building Construction, Experiential Learning, Architectural Education.

- To my father's soul;
  Once again, I wish you were here.
- To my mother;
  I am because of You.
- To my wife;
  Thanks for your support.
- To my two little lovely daughters;
  Because of you, I will be In Sha'a Allah.

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List of Acronyms

ACSA	**A**ssociation of **C**ollegiate **S**chools of **A**rchitecture
AI	**A**rtificial **I**ntelligence
CAI	**C**omputer-**A**ssisted **I**nstruction
CAL	**C**omputer **A**ided **L**earning.
CBE	**C**omputer-**B**ased **E**ducation
CDC	**C**ommunity **D**esign **C**enter
CMI	**C**omputer-**M**anaged **I**nstruction
ESRB	**E**ntertainment **S**oftware **R**ating **B**oard
IBM	**I**nternational **B**usiness **M**achines Corporation
LTM	**L**ong-**T**erm **M**emory
NAAB	**N**ational **A**rchitectural **A**ccrediting **B**oard
NPD	**N**ational **P**urchase **D**iary
PC	**P**ersonal **C**omputer
RIBA	**R**oyal **I**nstitute of **B**ritish **A**rchitects
STM	**S**hort-**T**erm **M**emory

List of Terms and Definitions

ASYNCHRONOUS LEARNING
Learning where people are not online at the same time and interaction does not occur without a time delay, allowing people to participate on their schedules.

AVATAR
Originally an earthly incarnation of a Hindu God, in virtual reality it refers to a user's graphical representation within a virtual world.

BULLETIN BOARD SYSTEM
A system maintained by a host computer for posting information, carrying on discussions, uploading and downloading files, chatting, and other online services. BBSs are generally created for a specific group of users and are usually topic-specific.

DISTANCE LEARNING
A learning system in which education is delivered to students who are not physically "on site". Rather than attending courses in person, teachers and students may communicate at times of their own choosing by exchanging printed or electronic media, or through technology that allows them to communicate in real time.

E-LEARNING
Learning that is accomplished over the Internet, a computer network, via CD-ROM, interactive TV, or satellite broadcast.

E-MAIL
Short for electronic mail; primarily text messages sent between two computers.

EXPERT SYSTEM
An application program that includes both information about a certain problem and information about how to manipulate that information, thus functioning as effectively as a human expert at his highly specialized task.

INFERENCE
The process by which new facts are derived from established facts.

MULTIMEDIA
A combination of text, graphics, audio and colors used to create and present information in an engaging and dynamic way.

SELF-PACED LEARNING
Learning that is done asynchronously, such as from CD-ROM or over the Internet without an instructor, where the user controls the flow of course material.

SYNCHRONOUS LEARNING
Learning where people are online at the same time and interaction occurs without a time delay (real-time) and which requires them to attend at specific times.

USER INTERFACE
The link between a computer program and the outside world.

Introduction

The educational process is normally based upon three main elements; lecturer, student, and curriculum. The territory shaped by the interaction of these three elements represents the full educational process, whose success depends on the success and validation of each individual element. The mutual interaction between each two elements takes place within a frame of tools and methodologies that, in turn, form the limitations and availabilities of the educational process.

For the mutual interaction between student and lecturer, there are two main approaches for achieving this relation; "Reception Learning" or the "Passive Teaching" and "Discovery Learning" or the "Active Teaching". "Reception Learning" may be defined as a unidirectional process through which students are required to absorb knowledge and data offered by instructor. This teaching approach is called "Teacher Centered Education". On the other hand, "Discovery Learning" may be defined as a bidirectional process within which the student constructs his/her own knowledge through the mutual interaction, discussion and research with the instructor. Theorists found that the effectiveness of an educational process is affected by the teaching approach. In case of the unidirectional approach, the teaching effectiveness does not exceed 50% in its best case. On the other hand, it varies from 50% to 90% in the bidirectional teaching approach.

Hence, "Discovery Learning" teaching approach is considered as the most appropriate for teaching, particularly in applied sciences teaching.

1-Architectural Education:

Architecture is the product of combining Scientific, Social and Aesthetic disciplines that are equally important to shaping the architectural domain. That accounts for the steady development for architectural education as it feels the impact of rapidly changing social needs.

Due to such a unique character, architecture cannot be described as a unidirectional field, but rather it is bidirectional. Hence, both the student and instructor should share in the architectural educational process to develop the student's mental skills and abilities. This is why many voices call for using the "Student Centered" models in architectural education as they enhance the new architect's character and abilities.

2-Thesis Problem:

Although using "Student Centered" models in architectural education is nearly a general demand of contemporary architectural educators, many obstacles face this teaching approach in the architectural education field. Some of these obstacles are intellectual as they are caused by the beliefs,

inclinations and attitudes of the educators themselves and the students. Other obstacles are technical as they are caused by factors such as the limited resources and time that are available for teaching architecture.

Rejection of the "Student Centered" teaching approach in architecture is two fold: first, that the discipline has been shaped in accordance with classical models, emanating from the French model of "Beaux Arts" and the German model of the "Bauhaus". The second reason has to do with technical factors as educators never had the chance to acquire a teaching experience based on "Student-Centered" teaching approach due to lack of resources and time pressure. As a result, a fair judgment of the approach has never been made and educators prefer the earlier techniques, they are acquainted with instead.

From the students perspective, the pre-college educational system is based on "Teacher-Centered" educational approach. Hence, fresh college students are unwilling to build knowledge through the adoption of a different learning approach.

Regarding the technical factors, many obstacles exist. For example, the time needed for teaching the different subjects, tools and equipments are some of that contribute to making the "Student Centered" teaching approach unobtainable and sometimes inaccessible.

Consequently, "Student-Centered" teaching models are hardly used for teaching architecture. That makes it essential to find a tool that helps overcome at least, the technical barriers, thus paving the way for making a fair judgment of the "Student-Centered" teaching approach.

Many other educational fields experienced similar problems while applying "Student Centered" approach in education. All fields relying on negotiation, multidisciplinary interaction, first person contact with clients and others, searched for a strategy or a tool to overcome these problems and most of them adopt simulators, digital training models and games as a solution one way or another.

"Simulation programs" as a term represents a wide variety of programs. In the architectural field itself, many simulation programs are used, but in most cases, they serve technical architectural issues like acoustics, thermal performance, daylight simulation, sun path analysis, HVAC installations and others. Such programs, in fact, are digital mathematical models rather than simulation programs. No one can deny the great importance of these programs, and how much they improve the performance of any design quality, but they fall short of meeting the required needs. Issues like social impact on the design process, negotiation phase of multi specialists

which is a core phase of the profession, the mutual impact of technicians actions, the decision making experience achieved through a long period of practice, and other issues, can not be taught with the help of current technical digital models. In other words, they give the user a solution of a technical problem rather than help to learn how to conduct problem analysis, solution optimization and other important mental skills. More over, two main points may be indicated to clear out why these technical programs failed to completely fulfill the educational needs; technicality and specialty.

Technicality: These programs are mainly directed towards special technicians, those who are professionals and knowledgeable in their fields. These programs have technical interfaces, scientific terms and some times a complex method of data entry. Although this may suit specialists but for sure, it is not in case of students.

Specialty: This means that every program is specialized in a single field, so that in most cases the mutual impact of multidisciplines cannot be demonstrated. In addition, they cannot be used to simulate the negotiation phase, the decision making process or the dealing with client phase. Therefore, the use of such programs is neither appropriate nor adequate.

In other fields like economics, politics, military planning, business administration, urban planning, project management and other similar fields, another kind of simulation programs is used; training abstracted simulation programs. They are used as a tool for teaching the "problem solving" process rather than the "problem solution" itself. Usually, these simulation programs are called "Games".

3-Thesis Hypothesis:

With the success attained in various areas such as military, economics, urban planning and politics in using games as educational tools, games are applicable as educational tools for teaching architecture through a "Student Centered" teaching approach.

4-Thesis Aim:

This thesis aims at drawing a conceptual framework of a digital educational game, which can be used as an educational tool in architectural education through a "Student Centered" methodology.

5-Thesis Objectives:

For achieving the above aim, many objectives should be accomplished. These objectives are:

1. Pointing out:
    a. The main characteristics of the significant educational theories especially those associated with the "Student Centered" learning approach.
    b. The contemporary architectural education needs according to theorists and educators views.
    c. The digital technology utilization in developing the educational process.
    d. The academic definition of the term "Games".
    e. The commercial and the academic games taxonomies and the main characteristics of each.
    f. The psychological and physical impact of playing games.
    g. The abilities of the educational games, their main characteristics, what abilities and skills may be developed by games, how far games can transfer knowledge, why games may be more successful as a knowledge transferor or skills developer and to what extend these are actually adopted.
2. Investigating the availabilities of the On-The-Shelf digital commercial games to fulfill the needs of the required architectural educational tool.
3. Choosing an architectural curriculum, that lends itself to be a typical example, to be used as a case study of the thesis. Based on this a game will be designed to be used as an educational tool for this course.
4. Indicating the skills, knowledge and abilities that are supposed to be developed and gained by playing the required game.
5. Developing the conceptual framework of the required game by configuring out its:
    a. Narrative context.
    b. Physical setting.
    c. Scenario of playing.
    d. Controls.
    e. Target audience.
    f. Pedagogical approach.
    g. Direct and indirect objectives.

h. Levels. In each level, these points will be identified:
    i. The construction problem explored.
    ii. The narrative context.
    iii. The physical context.
    iv. The help content and material.
    v. The Player's performance assessment criteria.
    vi. The "knowledge" that the player is supposed to gain by the end of the level.
    vii. The skills and abilities the player is supposed to develop directly by the end of the level.
    viii. The skills and abilities the player is supposed to develop indirectly by the end of the level.
i. Involved technology.
j. Educational final gain.

6-Thesis Methodology:

For accomplishing the thesis objectives, many methodologies are used. Based on the objectives that are mentioned above, these methodologies are:

1. Doing a literature review to accomplish the thesis objective number one.
2. Doing an analytical study to accomplish the thesis objective number two.
3. The researcher used his own view and personal free choice to accomplish the thesis objective number three.
4. Doing an analogy based on the accreditation criteria of the NAAB and the RIBA to accomplish the thesis objective number four.
5. Doing a deduction analysis of the third and fourth thesis objectives and re-synthesize them into chunks that can be implied into a narrative context to accomplish the thesis objective number five.

7-Thesis Scope of Work:

The thesis scope of work is limited to the computer games played on the personal computers; desktops or laptops, as they are the most widespread technology in our local community and our academic labs. Hence, the formal, non-digital, games such as the games of *Henry Sanoff* in "*Design Games*" and others will not be included in the thesis scope of work. Moreover, the digital games played on consol stations or hand held ones are not included.

8-Thesis Structure

8-1-Part One:

Through this part, the thesis investigates the education field, the architectural education field and the digital technology involvement in the educational field. This part contains three chapters.

8-1-1-Chapter One:

This chapter concerns the educational process in general; its definitions, theories, teaching models and other related topics. The aim of this chapter is to underline the most popular educational theories and teaching models, their characteristics, advantages, disadvantages, rules and aims. This investigation aims at pointing out a set of assumptions that should be considered as the basic criteria when it is the time to design a digital educational tool, which is the aim of the thesis.

8-1-2-Chapter Two:

This chapter investigates the architectural education; its aims, initiation and development, its contemporary needs, and other related issues. The thesis tries to point out the losses and gains of the contemporary architectural education and to clarify how it responds regularly to the surrounding social needs and trends. A literature review underlines what the architectural educators ask for to develop the current educational process of architecture. The main aim of this chapter is to present a list of guidelines to be considered while drawing the game's framework for the sake of fulfilling the contemporary and future needs of architectural education.

8-1-3-Chapter Three:

This chapter addresses the modern digital technology involvement in the educational process. It looks into how it affected and involved in the educational process. The main aim of this chapter is to pave the way for the searching about the games usage as educational tools and to underline the main differences between games and other similar digital products like simulators and digital models. In addition, this chapter aims at correcting the misconceptions about the term "Game" and the gaming process in general.

8-2-Part Two:

Through this part, the thesis investigates the educational games as a specific matter of games in general; the availability of using digital games to fulfill the needs of the architectural education and finally draws out a

conceptual framework of a digital game to be used in the architectural education. This part contains three chapters.

8-2-1-Chapter Four

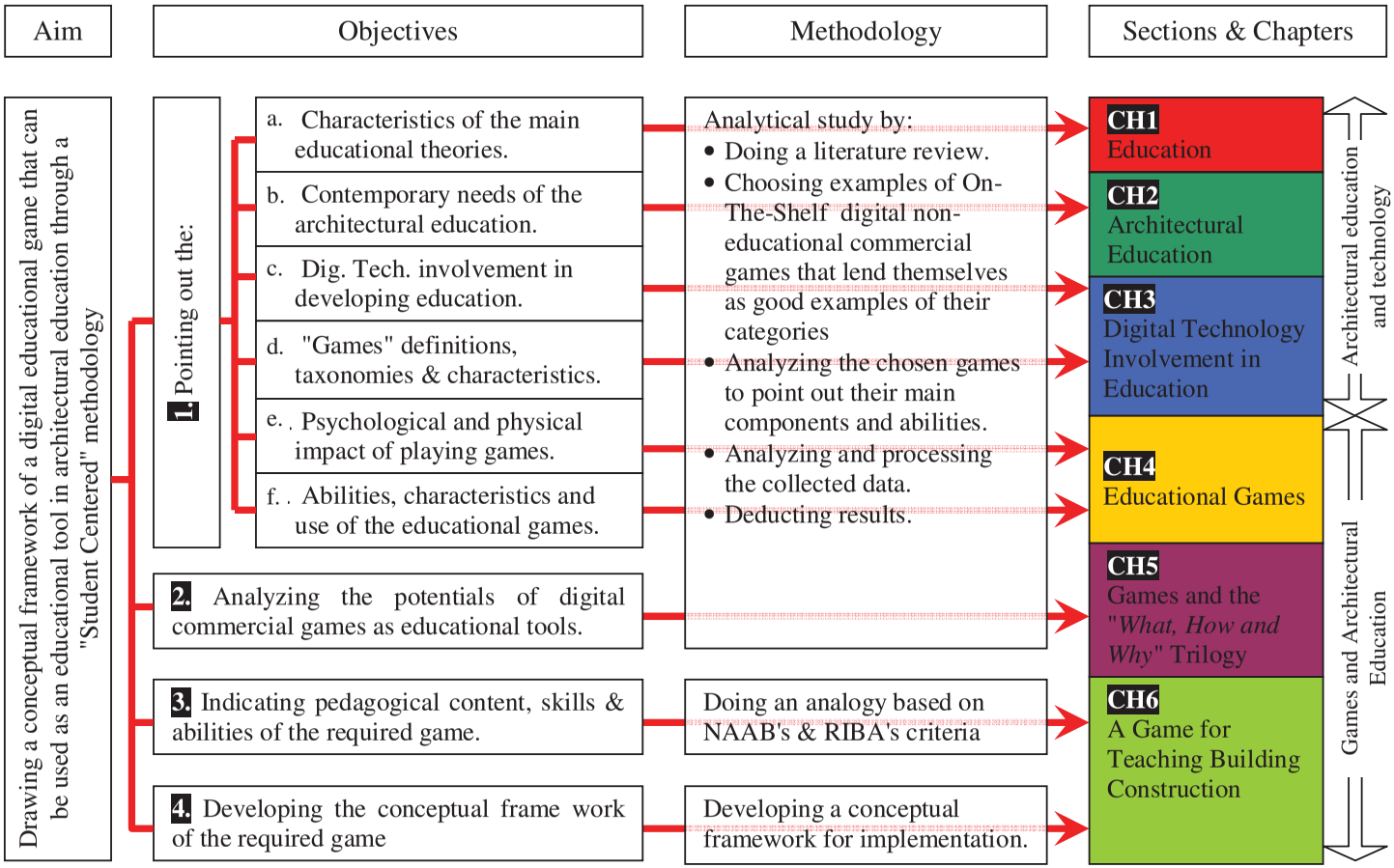
This chapter covers the educational games; their history, characteristics, usages, advantages and disadvantages and other related issues. Through a literature review, this chapter underlines the advantages of using games in the educational process. It determines games abilities and gaming process advantages and disadvantages. In addition, games ability to transfer knowledge and develop the players skills is discussed. In addition, this chapter mentions some serious attempts to use games as educational and training tools to clarify how serious and applicable they are. The main aim of this chapter is to value the gaming experience and correct the misconception existing about the usage of games in the educational process.

8-2-2-Chapter Five

This chapter investigates the possibilities of using the on-the-shelf digital games as architectural educational tools. It analyzes the needs of the architectural education trilogy "*What, How, and Why*" and uses this analysis as a benchmark to investigate some chosen on-the-shelf digital games. This chapter aims at proving that there are on-the-shelf digital games that can fulfill the needs of the architectural education trilogy "*What, How, and Why*".

8-2-3-Chapter Six

This chapter draws out a conceptual framework of a proposed digital game that can be used as an educational tool for teaching/learning an architectural curriculum as a case study. Based on the NAAB and RIBA validation criteria, it points out the list of skills and abilities supposed to be developed by playing the game. After that, the conceptual framework of the game is drawn out.


Aim
Objectives
Methodology
Sections & Chapters
Drawing a conceptual framework of a digital educational game that can be used as an educational tool in architectural education through a "Student Centered" methodology
1. Pointing out the:
a. Characteristics of the main educational theories.
b. Contemporary needs of the architectural education.
c. Dig. Tech. involvement in developing education.
d. "Games" definitions, taxonomies & characteristics.
e. . Psychological and physical impact of playing games.
f. . Abilities, characteristics and use of the educational games.
2. Analyzing the potentials of digital commercial games as educational tools.
3. Indicating pedagogical content, skills & abilities of the required game.
4. Developing the conceptual frame work of the required game
Analytical study by:
• Doing a literature review.
• Choosing examples of On-The-Shelf digital non-educational commercial games that lend themselves as good examples of their categories
• Analyzing the chosen games to point out their main components and abilities.
• Analyzing and processing the collected data.
• Deducting results.
Doing an analogy based on NAAB's & RIBA's criteria
Developing a conceptual framework for implementation.
CH1 Education
CH2 Architectural Education
CH3 Digital Technology Involvement in Education
CH4 Educational Games
CH5 Games and the "What, How and Why" Trilogy
CH6 A Game for Teaching Building Construction
Architectural education and technology
Games and Architectural Education

Part One: Architectural Education and Technology

This part consists of three chapters. The first chapter concerns the educational process in general; its definitions, theories, teaching models and other related topics. The second chapter addresses the architectural education objectives, initiation, development and contemporary needs. The third chapter addresses the modern digital technology involvement in the educational process.

1- Chapter One: Education

"To be able to organize the body of knowledge and skills to be learned in this year properly, to find suitable methods of transferring them to students, and to achieve maximum efficiency in teaching requires an awareness of different pedagogical approaches and the implications of any chosen method of instruction on the students. On the other hand, these should be discussed in relation to objectives of education as a whole, and objectives of college education and architectural education consequently."[1]

[1] Farivarsadri, Guita; A critical view on pedagogical dimension of introductory design in architectural education, Proceedings of AEE 2001- Architectural Education Exchange, Architectural Educators: Responding to Change, September 2001, Cardiff, England.
http://cebe.cf.ac.uk/aee/pdfs/farivarsadrig1.pdf Accessed 27/9/2004

Introduction:

As the main aim of this thesis is to provide a conceptual methodology for a technological educational tool to be used in architectural education, it is important to define at first what the term "Education" means. It is necessary to address its: meaning, processing steps, theories and other important issues. Thus, through this chapter, "Education" will be discussed as a "Process" and as a "Meaning". The difference between "Learning" and "Teaching" will be identified and terms like "knowledge", "Metacognition" and "Information Process" will be explained. Moreover, Theories like "Learning theory", "Cognitive Load theory" and "Instruction Design theory" will be examined to determine their effect on the "Education Outcome". Finally the most known "Teaching Models" will be discussed to define their advantages and disadvantages, and their usage area.

1-"Education" Definition:

> *Webster defines education as the process of educating or teaching. […] Educate is further defined as "to develop the knowledge, skill, or character of...".*"[2]

So "Education" may be defined as a process, through which, knowledge is transferred from "Tutor" or "Instructor" to "Student". This transferring process is called "Teaching" or "Learning" as viewed by "Tutor" and "Student" respectively[3]. However, although this is a simple definition, it contains many terms that need to be defined more clearly. Knowledge, Instruction, Teaching and Learning, all of them need to be explained. In addition, how the "Knowledge Transferring Process" is accomplished? More over, what is meant by educating others?

2-Instruction/Teaching Definition:

"Instruction" may be defined as a process of delivering knowledge to others[4], but it's an insufficient definition to clarify all meanings of "Instruction". "Instruction" is a multifaceted term. For example, *Brent G. Wilson* cites definitions that suggest "Instruction" to be what goes on in

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[2] Yero, Judith Lloyd; The Meaning of Education, Teacher's Mind Resources, http://www.teachersmind.com/education.htm accessed 08/09/2004

[3] Abdel Kader, Sherif Morad; Towards A Conceptual Framework For Implementing Intelligent Mixed Reality In Architectural Education, Unpublished M. Sc. Thesis, Architecture Dept., Faculty of Engineering, Ain Shams University, 2003, p.7

[4] ibid., p. 9

classrooms during 50-minute intervals. In addition, he cites other definitions of instruction that tend to emphasize the steps or stages, inputs and outputs, interlocking mechanisms, and control of flow. Moreover, as it is shown in *Table [1]* instruction definition may change according to how "knowledge" is defined[5].

Table [1]: Instruction definitions
Brent G. Wilson

If you think of knowledge as...	Then you may tend to think of instruction as...
a quantity or packet of content waiting to be transmitted	A product to be delivered by a vehicle.
a cognitive state as reflected in a person's schemas and procedural skills	Set of instructional strategies aimed at changing an individual's schemas.
a person's meanings constructed by interaction with one's environment	A learner drawing on tools and resources within a rich environment.
enculturation or adoption of a group's ways of seeing and acting	Participation in a community's everyday activities.

Anyway, whatever the definition is, "Instruction" has a major role and important long-term output that are undoubted. The role is to create powerful learners, and the important long-term outcome is the students increased capabilities to learn more easily and effectively in the future, both because of the knowledge and skill they have acquired and because they have mastered learning processes[6].

3-Learning and Learning Environment Definitions:

There are two terms related to the state of gaining knowledge; "Learning" and "Learning Environment".

3-1-Learning:

> *"Learning may be defined as the encoding (storage) of knowledge and/or skills into long term memory in such a way that the knowledge and skills may be recalled and applied at a later time on demand."*[7].

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[5] Reflections on Constructivism and Instructional Design, In Dills & Romaniszowski (ed.) Instructional Development Paradigms. Englewood Cliffs, NJ: Educational Technology Publications. http://carbon.cudenver.edu/~bwilson/mainties.html accessed 07/08/2004

[6] Teaching / Learning Models, http://hagar.up.ac.za/catts/learner/cooplrn/b3.htm accessed 03/08/2004

[7] Cooper, Graham; Research into Cognitive Load Theory and Instructional Design at UNSW, School of Education Studies, The University of New South Wales, Sydney, NSW 2052, Australia, 1998 http://education.arts.unsw.edu.au/CLT_NET_Aug_97.HTML accessed 08/15/2004

Storing knowledge here does not mean just "To Keep" it in mind, it means "To Understand", "To Remember" and "To have a nearly permanent change in knowledge or behavior because of experience"[8].

3-2-Learning Environment:

Learning needs an environment to be established within, this is called "Learning Environment". It is a facilitated environment[9] wherein learners act, using tools and devices, collecting and interpreting information, interacting perhaps with others, to make sense out of things and solve problems[10]. Generally, a "Learning Environment" has to have:

- Information resources: to offer data to students.
- Tools: to facilitate students activities.
- Proper support and guidance.

After addressing the definitions of "Education", "Instruction" and "Learning" and the role of each one of them in the knowledge transferring process, the thesis will investigate the "Knowledge" itself.

4-Knowledge Definition:

There are two types of the knowing state; the first is called "Knowledge" and the other is called "Metacognition".

4-1-Knowledge:

When one teaches himself, or a tutor instructs others, both of them aim to gain/give certain information about facts, principles and concepts. These facts, principles and concepts are called "Knowledge"[11].

As it has been mentioned before while defining "Instruction", knowledge may be seen as[12]:

- A quantity or packet of content waiting to be transmitted.
- A cognitive state as reflected in a person's schemas and procedural skills.

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[8] Ruttan, Joanne; Comparing Behavioral, Cognitive, and Agentive Psychology
http://mse.byu.edu/ipt/ipt301/jordan/learning.html accessed 07/08/2004

[9] Wilson, Brent G.; What is a constructivist learning environment?, in B. G. Wilson, Constructivist learning environments: Case studies in instructional design, Englewood Cliffs NJ: Educational Technology Publications, 1996.

[10] "Adding 'constructivist' to the front end of the term is a way of emphasizing the importance of meaningful, authentic activities that help the learner construct meaningful understandings and skills relevant to solving problems." (Wilson, Brent G.)

[11] Abdel Kader, Sherif Morad; Towards A Conceptual Framework, p. 10

[12] Wilson, Brent G.; Maintaining the Ties between Learning Theory and Instructional Design.

- The person's meanings constructed by interaction with one's environment.
- Enculturation or adoption of a group's ways of seeing and acting.

Although these are multi definitions of one term, they all have the same spirit. Difference comes from how the theorists think of the education role as it will be seen later while talking about "learning theory". Whatever the definition is, knowledge may be classified into:[13]

1. **General Knowledge**: This is the information that is useful in many different kinds of tasks.
2. **Domain Specific Knowledge**: This is the information that generally applies only to one situation.
3. **Declarative Knowledge**: This is the verbal information and lists of facts. Information that can be taught through lectures or acquired through books, verbal exchange, Braille, sign language and so on.
4. **Procedural Knowledge or Skills**: that are demonstrated when we perform a task.
5. **Conditional Knowledge**: Knowing when and why to use declarative and procedural knowledge.

4-2-Metacognition:

"Metacognition" may be defined as[14]:

"Knowledge about our own thinking. Planning how much time to allocate to a certain task, monitoring how well we are doing and if we should change strategies, and evaluating our efforts to see if we have done an adequate job."

Although Metacognition may be defined simply as "thinking about thinking"[15], it has an important role in educating others. As students become more skilled at using metacognitive strategies, they gain confidence and become more independent as learners. This independence gives students the ability of pursuing their own intellectual needs. Metacognition consists of two simultaneous basic processes[16]:

- Learner monitors his/her progress as he/she learns.

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[13] Ruttan, Joanne; Comparing Behavioral, Cognitive, and Agentive Psychology.

[14] ibid.

[15] Wahl, Jan; Metacognition, Encyclopedia of Educational Technology
http://coe.sdsu.edu/eet/Articles/metacognition2/start.htm accessed 08/08/2004

[16] Halter, Julie; Metacognition, Encyclopedia of Educational Technology
http://coe.sdsu.edu/eet/Articles/metacognition/start.htm accessed 8/8/2004

- Learner adapts his/her strategies whenever he/she perceives he/she is not doing so well.

Hence, as it has been mentioned before, the major role of the tutor is to create powerful learners, it is also his/her main task to acknowledge, cultivate, exploit and enhance the metacognitive capabilities of all learners[17].

This raises a question, how does a learner deal with knowledge? In other words, how does learner's brain deal with any offered information? This is what is called "Information Processing model"

5-Brain Processing of Information:

Two matters need to be discussed to explain how the brain processes information. The first is the "Processing Information Model" which explains how any offered information is processed. The second is "Cognitive Load Theory" which suggests strategies to maximize brain ability of storing information.

5-1-Information Processing Model

To define the Information Processing Model, first we have to define memory. According to Orangi memory may be defined as[18]:

> *"What we call memory is this faculty to reproduce unconscious contents, and it is the first function we can clearly distinguish in its relationship between our consciousness and the contents that are actually not in view."*

In addition, two types of memory have been defined[19]:

- Episodic memory: The recall of detailed and sequential events.
- Semantic memory: Intentional learning, which involves encoding, storage and retrieval of information.

Therefore, when one learns, it is the "Semantic Memory" that is involved. Here, the brain deals with the offered information through three stages: 1) Input or sensory memory, 2) Short-term memory, 3) Long-term memory. This is what is called "Stages of Information Processing Model"[20]. Through defining these stages, "Information Processing Model" will be also defined.

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[17] ibid.

[18] Orangi, Hanieh; Working memory, Encyclopedia of Educational Technology
http://coe.sdsu.edu/eet/articles/workingmemory/start.htm accessed 08/08/2004

[19] Information Process Theory of Learning
http://tiger.coe.missouri.edu/~t377/IPTheorists.html accessed 08/08/2004

[20] ibid.

5-1-1-Sensory memory

Sensory Memory is the first step of information processing as it reacts to both visual and auditory information. Although it has unlimited capacity, the duration of keeping information in is extremely brief, perhaps only 300 milliseconds[21], and is subject to rapid decay.

5-1-2-Short-Term Memory (STM) or Working Memory

After information goes into sensory memory, a limited amount of it is transferred into Short-Term Memory (STM). Theorists found that the number of items which can be held in STM at any one time is about 7 independent chunks of items[22]. This means, if there are more items that are supposed to be put into STM, what exceeds the 7th chunk will be most probably lost.

STM prepares information to be encoded into Long Term Memory (LTM), preparation here means organizing information elements into certain groups. This is what is called "Chunking" information. In this organization process the meaningfulness or emotional content of an item may play a greater role in its retention into LTM. Also, this process is affected by one's prior knowledge[23] which affects how sensory information is perceived. It has been demonstrated that one's expectations regarding a particular sensory experience influence how it's been interpreted[24].

Theorists[25] defined that processing the sensory information is handled by two different subsystems.

- Verbal input is handled by a subsystem that specializes in language.
- Nonverbal input is handled by a subsystem that specializes in images or sensations. The term "Images" here refers to visual, auditory, kinesthetic, or olfactory inputs.

STM uses these two subsystems to prepare information to be encoded and transferred into LTM. Some times, STM recycles the offered information repeatedly instead of transferring it into the LTM until it is used, then it decays. This operation of the STM may be considered as the same system as

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[21] Pastor, Marc; Short-Term Memory, Encyclopedia of Educational Technology
http://coe.sdsu.edu/eet/Articles/stmemory/start.htm accessed 08/08/2004

[22] ibid.

[23] Easton, Jeff; Long-Term Memory, Encyclopedia of Educational Technology
http://coe.sdsu.edu/eet/Articles/ltmemory/start.htm accessed 08/08/2004

[24] This is how "optical Illusion" works; we perceive what is related to our prior knowledge even if it isn't exactly what we exactly see.

[25] Adair, Ray; Sense and Memory, Encyclopedia of Educational Technology
http://coe.sdsu.edu/eet/Articles/senseandmemory/start.htm accessed 08/14/2004

LTM[26], but is used under rather special conditions which result in very little long-term retention[27].

5-1-3-Long-Term Memory (LTM)

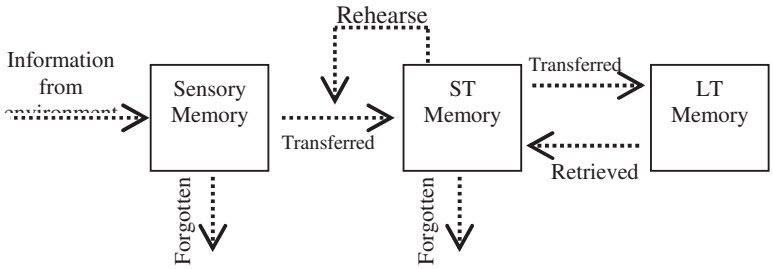

Figure 1: Information Processing Model
Easton, Jeff

This is where the brain efficiently stores one's knowledge about the world[28]. This knowledge is organized through packages or mental models called "Schemas". Related schemas are linked together through a network; any information that activates one schema also activates others that are closely linked. This is how relevant knowledge is called up when information is presented. These interrelated networks are called "Schemas Networks"[29]. As it has been mentioned before, stored knowledge in LTM and schemas patterns strongly influence one's perception of sensory information. It also provides a framework to which we attach new knowledge. Information Processing Model may be represented by *Figure 1*.

Now, it is clear how brain deals with offered information, but how does this affect the educational process? This is what will be discussed through defining the "Cognitive Load Theory".

5-2-Cognitive Load Theory:

> *"Cognitive load theory is concerned with techniques for reducing working memory load in order to facilitate the changes in long term memory associated with schema acquisition"*[30]

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[26] Orangi, Hanieh, Working Memory, Encyclopedia of Educational Technology
http://coe.sdsu.edu/eet/articles/workingmemory/start.htm accessed 08/08/2004

[27] "Think of a phone number you'll repeat to yourself until you can dial it", Marc Pastor, ibid.

[28] Easton, Jeff; Long-Term Memory, Encyclopedia of Educational Technology
http://coe.sdsu.edu/eet/Articles/ltmemory/start.htm accessed 08/08/2004

[29] ibid.

[30] Soloman, Howard; Cognitive Load Theory (J. Sweller)
http://tip.psychology.org/sweller.html accessed 08/15/2004

As it has been mentioned before, the working memory or short memory has a limited storage capacity. Also, any knowledge that is supposed to be encoded into the LTM must first be attended to, and processed by, the working memory. Hence, the working memory capacity plays an important role in the educational process. This capacity may be a strong threat to learning efficiency if it is not put into consideration while planning the instruction. Hence, the theory suggests reducing the cognitive load on the working memory as far as possible to give more chance to much knowledge to be encoded into LTM[31].

Hence, the theory splits the total cognitive load affecting the working memory into two types[32]:

- **Intrinsic cognitive load**: is caused by the learnt knowledge difficulty. This cognitive load cannot be modified by instructional design.
- **Extraneous cognitive load**: is due to the form, in which, instructional materials is presented. This happens when tutor presents conflicting materials or data redundancy. Moreover, it happens between verbal and non-verbal inputs when they are used unwisely. This causes an overload on the working memory while using its subsystems that specialized in dealing with verbal and non verbal inputs.

So, it is so important that tutors revise the instruction material to reduce the extraneous cognitive load as far as possible.

The theory also states a term called "Level of Element Interactivity"[33]. This may be defined as element independency. When information elements are simple and independent, they are "Low Interactive Elements". This causes less cognitive load on the working memory. On the other hand, when information elements have certain relationships between each other, they are called "High Interactive Elements". This type of information causes more cognitive load on the working memory[34].

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[31] Cognitive load theory and the format of instruction, Cognition and Instruction, 1991, Vol. 8, No. 4, pages. 293-332.

[32] Cooper, Graham; Research into Cognitive Load Theory and Instructional Design.

[33] ibid.

[34] Think of these two cases like learning "language vocabulary" and learning "language grammar". The first one is a "low Interactive elements" because each element –letter- does not affected by the other element. But the second case is "High Interactive Elements" because each element affects the validity and shape of the other element according to a grammatical rule.

The theory suggests two mechanisms[35] to circumvent the limits of working memory by drawing on our long-term memories, which are very detailed and powerful:

- The first mechanism is "Schema Acquisition", which allows us to chunk information into meaningful units. This one deals primarily with processing and understanding information.
- The second mechanism is "Automation of Procedural Knowledge", which deals with the acquisition of skills.

Now, it has been defined how brain deals with the offered information. In addition, it has been explained how a tutor can maximize the brain ability of gaining knowledge. But it is still undefined, what is the aim of the educational process? In other words, how one should be altered to become educated? This is the concern of what is known as "Learning Theories".

6-Learning Theories:

The learning theories may be defined as psychological theories that are trying to explain how learners are supposed to be changed because of being educated and gaining knowledge. Also, they serve as a foundation for instructional prescriptions[36]. Although there are many learning theories that are trying to put rules and definitions of the learning process, but all of them may be classified into three main classes; "Behaviorism", "Cognitivism" and "Constructivism". Through the coming section the thesis will explain these theories briefly by addressing their definitions and construction goals.

6-1-Behavioral Learning Theory:

6-1-1-Definition:

This theory[37] focuses on changes in behavior. It indicates that learning happens when a correct response is demonstrated following the presentation of a specific environmental stimulus. It also considers knowledge as a separate package to the human mind and that it must be transferred to learners in a teacher centered approach[38].

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[35] Wilson, Brent G.; Maintaining the ties between learning theory and instructional design

[36] ibid.

[37] Ruttan, Joanne; Comparing Behavioral, Cognitive, and Agentive Psychology

[38] Forrester, Darren & Jantzie, Noel; Learning Theories
http://www.ucalgary.ca/~gnjantzi/learning_theories.htm accessed 8/16/2004

6-1-2-Instruction Goals:[39]

- Transferring behaviors that represent knowledge and skills to the learner without the need to care about the process of the brain's information processing.
- Instruction is to elicit the desired response from the learner who is presented with a target stimulus.
- Learner must know how to execute the proper response as well as the conditions under which the response is made.
- Instruction utilizes consequences and reinforcement of learned behaviors.

6-2-Cognitive Learning Theory:

6-2-1-Definition:

This theory[40] focuses on changes in knowledge. It considers learning as an active mental process of acquiring, remembering, and using knowledge. According to the theory, Knowledge is a cognitive state as reflected in a person's schemas and procedural skills.

6-2-2-Instruction Goals:[41]

- Transferring knowledge is done in the most efficient and effective manner (mind-independent, can be mapped onto learners).
- Focus of instruction is to create learning or change by encouraging the learner to use appropriate learning strategies.
- Learning results when information is stored in memory in an organized, meaningful way.
- Tutors are responsible for assisting learners in organizing information in an optimal way so that it can be readily assimilated

6-3-Constructivist Learning Theory:

6-3-1-Definition:

This theory[42] focuses on a learner's ability to mentally construct meaning of their own environment and to create their own learning. It regards

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[39] George Mason University, Instructional Technology Program, Learning Theories and Instructional Strategies Matrix
http://chd.gse.gmu.edu/immersion/knowledgebase/ accessed 08/16/2004

[40] Forrester, Darren et. al.; Learning Theories.

[41] Learning Theories and Instructional Strategies Matrix.

[42] Forrester, Darren et. al.; Learning Theories.

the educational system as a process of matching skill objectives with test items experiences. Therefore, it considers knowledge as person's meanings constructed by interaction with one's environment.

6-3-2-Instruction Goals:[43]

- To build personal interpretations of the world based on individual experiences and interactions.
- Learning is an active process of constructing rather than acquiring knowledge.
- Instruction is a process of supporting knowledge construction rather than communicating knowledge.
- Do not structure learning for the task, but engage learner in the actual use of the tools in real world situations.

As a result of these theories many learning strategies had been put, each one represents an action plan that aims to achieve goals of the mother theory. This is what is called "Teaching Models"

7-Teaching Models or Instruction Models:

They are prescribed tested procedures to effectively generate desired learning outcomes. These models, in most cases, are related to an Instruction Design (ID) theory which, in turn, is relevant to a learning theory. So, teaching models may be considered as a procedural plan of an ID Theory.

Theorists define ID theory like this, if instruction is *"anything that is done to help someone learn"*, then ID theory is *"anything that offers guidance for improving the quality of that help"*[44]. So, ID theories serve as guides to professional practice. Hence, they are about "How to DO", not about "How they ARE"[45]. Difference between the ID theory and the Learning theory is the difference between methodology and aim. Learning theories are psychological theories discussing "how learners are supposed to be changed by the educational process". On the other hand, the ID theory concerns "How these changes will be achieved". Finally, teaching models present a procedural action plan to get the aimed outcome of education.

According to the learning theories they belong to, teaching models may be categorized as shown in *Table [2]*:

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[43] Learning Theories and Instructional Strategies Matrix.

[44] De Lisle, Peter; what is Instructional Design Theory?
http://hagar.up.ac.za/catts/learner/peterdl/ID%20Theory.htm accessed 07/08/2004

[45] Wilson, Brent G; Cole, P; Cognitive teaching models, in D. H. Jonassen (ed.), Handbook of research in instructional technology, New York: MacMillan.

Table [2]: Teaching models categorization
Learning Theories and Instructional Strategies Matrix

	Behaviorism	Cognitivism	Constructivism
Instructional design theory	• Programmed Instruction	• Events of Instruction	• Cognitive Apprenticeship • Cognitive Flexibility • Situated Learning • Zone of Proximal Development
Teaching models	• Behaviorism • Instructional cues to elicit correct response • Practice paired with target stimuli • Reinforcement for correct responses • Building fluency (get responses closer and closer to correct response) • Multiple opportunities/trials (Drill and practice) • Discrimmination (recalling facts) • Generalization (defining and illustrating concepts) • Associations (applying explanations) • Chaining (automatically performing a specified procedure)	• Information Processing Model • Explanations • Demonstrations • Illustrative examples • Gestalt Theory • Matched non-examples • Corrective feedback • Outlining • Mneumonics • Dual-Coding Theory • Chunking Information • Concept Mapping • Advanced Organizers • Analogies • Summaries • Keller's ARCS Model of Motivation • Interactivity • Synthesis • Schema Theory • Metaphor • Generative Learning • Organizational strategies • Elaboration Theory • Links to prior knowledge	• Modeling • Collaborative Learning • Coaching • Scaffolding • Fading • Problem-Based Learning • Authentic Learning • REALs • Anchored Instruction • Cognitive Flexibility Hypertexts • Object-based Learning

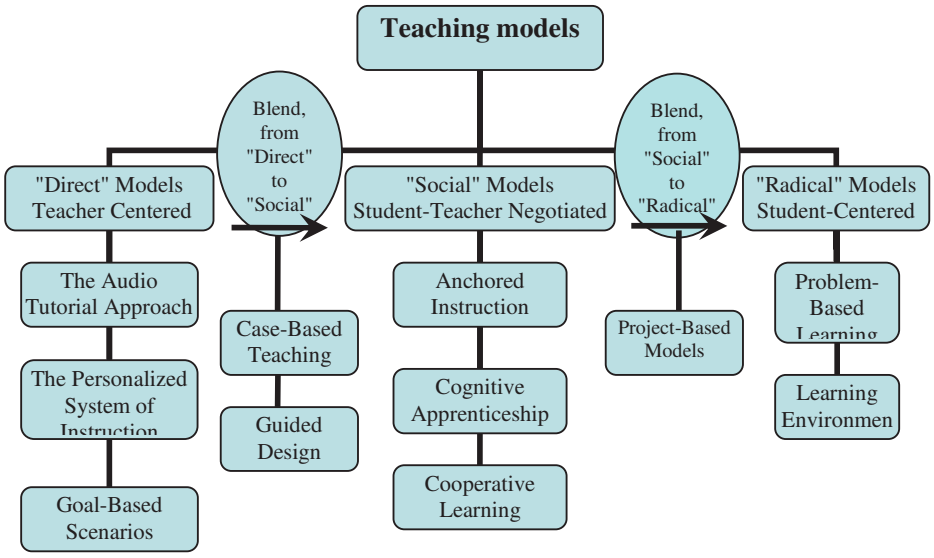

Figure 2: Teaching Models Chart
Chart developed by the author.

In addition, teaching models may be classified according to student's role in the educational process. From this point of view, teaching models may be classified into Teacher–Centered models, Teacher–Student Negotiated models and Student–Centered models. In between these three categories there are two more that represent a blending phase from one category to the other. This classification may be presented as shown in *Figure 2* that represents only examples, not exclusive, of the teaching models in each category.

Now it has to be explained how much student's participation affects the learning success. In other words, which teaching model type is better, Direct ones or Interactive ones?

8-Student's Participation Effect on the Educational Process Success:

Students role in the educational process may be classified into two types; passive participation and active participation. Passive students participation is when students do nothing more than gain knowledge through direct instruction. Here, students role is only to hear, see and read the offered instructional material. On the other hand, active students participation in the educational process means that students participate in preparing, presenting and doing actions -related to- the information that is supposed to be gained.

It has been proved that active students participation increases the learning success. In addition, the higher level of students active participation guarantees a higher success level of learning. This relation of student's participation "Type and Level" and learning efficiency may be represented by Edgar Dale's cone of learning *see Figure 3*.

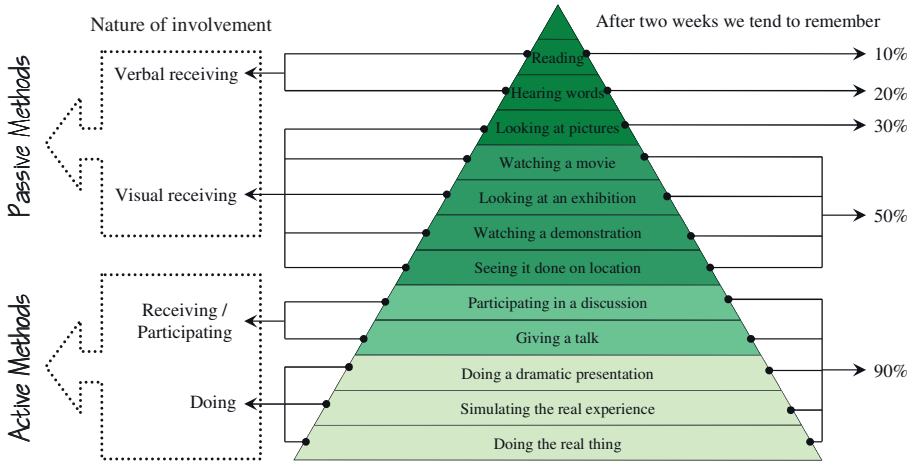

Figure 3: Cone of Learning
Edgar Dale, Audio-visual methods in teaching (3rd. ed.), Holt, Rinehart and Winston (1969)
Regenerated after Fannon, Kate

9-Chapter One Summary:

As a conclusion of the educational process investigation, the following concepts may be pointed out:

1. The most important role of a tutor is to help students to be good learners.
2. Any successful instruction has to contain all knowledge types "General, Domain, Declarative, Procedural and Conditional knowledge"
3. The Instruction Designer has to put into consideration how the brain deals with information to assure learning success.
4. Learner participation in the educational process guarantees a higher level of learning and skills acquisition.
5. Modern learning theorists prefer Cognitive learning theory and Constructivist learning theory rather than Behavioral learning theory that may be considered a unidirectional learning theory.

In addition, predicated on this brief investigation of the learning theories and teaching models one may assume that to enhance the teaching process it is necessary to:

1. Use an intelligent mix between verbal and non-verbal content to involve much more of the mental abilities of the students.
2. Decrease students confusion probabilities by implying the instruction content within a relevant context, which makes data, facts and knowledge more relevant and logic. Therefore, a better ability of drawing mental patterns (schemas) is achieved which fasten the knowledge encoding process in the working memory. Hence, a better knowledge gaining/retrieving ability may be achieved.
3. Decrease the extrinsic cognitive load by designing the instruction content carefully. Moreover, although it is hard to decrease the intrinsic cognitive load as it is due to the knowledge domain complexity, it is useful to imply such content within an engaging frame to increase the students involvement and interest.

Before investigating the ability of finding such a tool, which may offer the previously mentioned conclusions, it is necessary to investigate the architectural educational needs. Which learning style is the most preferable in the architectural education? Which teaching model may be used? To answer these questions it is important to define first what is architectural education? What does it aim at? What are its contemporary needs? The next chapter will try to find answers to these questions.

2- Chapter Two: Architectural Education

"The available literature on the subject portrays that it is widely noted in recent years that architectural practice has changed dramatically and that several corresponding changes in education are needed. There are continuous attempts to massage architectural curricula, to reconfigure the structure of the educational process, to test accepted ideas and to probes future visions. However fundamental disagreements exist over the goals and objectives, structures and contents, and tools and techniques required for architectural education in recent years."[1]

[1] Salama, Ashraf; A Voice for An Alternative Architectural Education: Integrating "What" and "How" Knowledge. An online published paper on Archnet.
http://archnet.org/file-storage/download/An+Alternative+Architectural+Education.doc?inode=66973
accessed 10/11/2004

Introduction:

After investigating the main educational theories, definitions and models, which have been accomplished through the last chapter as a general field, the thesis will go a deeper step. This chapter will investigate and define "Architectural Education" as a specific field of education. How it initiated? How it developed? How and why it should be developed? This chapter will address these issues by finding answers to some questions such as:

- How can we define "Architecture"?
- How did architectural education developed over time?
- What are the contemporary and future needs of architectural profession?
- How should be the contemporary architectural education?

1-"Architecture" Definition:

> *Webster defines "Architecture" as: The art or science of building; especially, the art of building houses, churches, bridges, and other structures, for the purposes of civil life; -- often called civil architecture"*[2]

However, is it a complete definition? Surprisingly literature review points out many definitions of the term "Architecture". Some of them are similar in meaning, although they are different literally, but also some of them differ in meaning. Starting from the far past when *Vitruvius*[3] defined "Architecture" as a science that is mastering many other sciences:

> *"Architecture is a science arising out of many other sciences, and adorned with much and varied learning; by the help of which a judgment is formed of those works which are the result of other arts."*[4]

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[2] Webster's 1913 Dictionary, hyperdictionary, online Dictionary
http://www.hyperdictionary.com/dictionary/%20architecture accessed 09/08/2004

[3] "Marcus Vitruvius Pollio (70?-25 BC), was a Roman architect and engineer. He was an artillery engineer in the service of the first Roman emperor, Augustus. His ten books on architecture, De Architectura (trans. 1914), are the oldest surviving work on the subject "Architecture". They consist of dissertations on a wide variety of subjects relating to architecture, engineering, sanitation, practical hydraulics, acoustic vases, and the like. Vitruviuss writings have been studied ever since the Renaissance as a thesaurus of the art of classical Roman architecture." Extracted from: Calter, Paul; Geometry in Art & Architecture Unit 7, 1998.
http://www.dartmouth.edu/~matc/math5.geometry/unit7/unit7.html accessed 09/14/2004

[4] Vitruvius, Marcus Pollio; de Architectura, Book I, chapter 1, English translation
http://penelope.uchicago.edu/Thayer/E/Roman/Texts/Vitruvius/1.htm accessed 09/13/2004

On the other hand, other definitions of architecture or architectural design emphasize the artistic side of "Architecture".

> *"Architectural design is not 'problem solving' – design may involve solving many problems, but at its origin architecture is a matter of making propositions; in this it is more like writing a novel, composing a sonata, constructing an argument…than solving a problem."*[5]

Moreover, other definitions arise to confirm and corroborate the social side of "Architecture" as a field of human activity.

> *"What is architecture anyway? Is it the vast collection of the various buildings which have been built to please the varying taste of the various lords of mankind? I think not. […] No, I know that architecture is life; or at least it is life itself taking form and therefore it is the truest record of life as it was lived in the world yesterday, as it is lived today or ever will be lived. So architecture I know to be a Great Spirit […] Architecture is that great living creative spirit which from generation to generation, from age to age, proceeds, persists, creates, according to the nature of man, and his circumstances as they change. That is really architecture."*[6]

Obviously then, the aforementioned definitions stated as examples sought to corroborate rather than deny the validity of each other. However, one may say that each of them confirms the importance and substantiality of one aspect of "Architecture" rather than the other. Consequently, contemporary viewpoints about "Architecture" espouse the integration of the three sides of architecture: art, science, and society.

> *"Architecture is an interdisciplinary field that comprises several major components: humanities, social and physical sciences, technology and the creative arts."*[7]

> *"Like scientists, architects rely on both a body of knowledge and a method of inquiry and invention. Like engineers, architects give form to function and application to materials and tools. And like*

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[5] Unwin, Simon; A Bridge into Architecture, Proceedings of AEE 2001- Architectural Education Exchange, Architectural Educators: Responding to Change, September 2001, Cardiff, England http://cebe.cf.ac.uk/aee/pdfs/unwins.pdf accessed 27/9/2004

[6] Wright, Frank Lloyd; from: In the Realm of Ideas, edited by Bruce Brooks Pfeiffer and Gerald Nordland, "ABOUT" an online web site http://architecture.about.com/library/blarchitecture.htm accessed 09/08/2004

[7] U.I.A. Work program 'education', UIA/UNESCO charter for architectural education. April 1996 http://www.unesco.org/most/uiachart.htm accessed 08/18/2004

artists, architects see potential project futures and translate aspirations into artifacts. The creation of architecture is a social act, involving a multiplicity of participants in design, development, execution, and occupancy"[8]

This variation of "Architecture" definitions represents how others perceive "Architecture" and how this perception has been developed over time because of specialists, theorists, practitioners and also normal individuals awareness of architect's role in society. Many factors controlled the general awareness of "Architecture" and its essence. These factors, either economi, political, or social, shaped the architectural field and how architecture was viewed over time.

2-"Architectural Education" Development over Time:

Two main architectural education systems have been developed through its existence: the guild system and the institutionalized educational system.

2-1-The guild system:

For almost the entirety of its past history, the architecture field used diffusion of knowledge and learning through chains of masters and pupils, webs of personal contacts, to reproduce itself. Starting from about the 12th century the processes of learning and building were integrated and strongly implanted in the fabric of society and it was controlled and guided by the guild system[9]. According to this model of architectural education those who wanted to learn had to join the guild and serve under the supervision of a master builder. Learners acquired their knowledge through a long period of experience and apprenticeship and their position in the hierarchy of the system indicates their degrees of specialization.[10]

It was about the mid of the 16th century when the guild influences started to be eroded and to be replaced by construction trade groups competing in the marketplace. This replacement was due to the rising power of capitalistic enterprises and the growing influence of free-market thinking

[8] The Redesign of Studio Culture, A Report of the AIAS Studio Culture Task Force, p19
http://www.aiasnatl.org/resources/r_resources_studioculturepaper.pdf accessed 29/09/2004

[9] Fisher, Thomas; Design Studio "The Past and Future of Studio Culture", "Archvoices", an independent, nonprofit organization and think tank on architectural education, internship, and licensure
http://www.archvoices.org/index.cfm?pg=Resources&s=IssueArchive&d=newsD&NID=1365&MaxResults=10&startrow=1&searchwords=&lineNbr=1 accessed 10/11/2004

[10] Awad, Mohamed; Reviving the Role of the Master Builder, or Moalem, in Architectural Education, in Ashraf M. A. (ed.), Architectural Education Today; Cross-Cultural Perspectives, Lausartne, 2002, p78
http://archnet.org/library/pubdownloader/pdf/8521/doc/DPC1197.pdf accessed 27/10/2004

that saw the guilds as a hindrance to free trade, eventually convincing the governmental authority that guild monopolies were more expensive and less efficient than capitalistic competition. At the same time, building designers in Europe began to call themselves architects and took in apprentices to teach in exchange for their labor that was what initiated the first idea of architectural schools. In about the second half of the 17th century some specialized architectural schools eventually emerged and this was the first glance of a new system of architectural education[11].

Figure 4: Sketches represnt the Guild System

2-2-Institutionalized educational system:

Starting from the mid of the 17th century a new form of architectural education has been evolved, the institutionalized educational system. This form of education mainly had, through its existence, three turning points or models of education which are, according to their existence, The "Beaux Arts" model, The "Bauhaus" model, and finally the American model.

2-2-1-The "Beaux Arts" model:

The 18th century shaped the first and main turning point in the architectural education form. At this time the French state created a new method of reproduction with the formation of a school intended to train architects, the École des Beaux Arts. The Ecole founded mainly to train top civil servants to work in the French government, generating prototypes for

[11] Fisher, Thomas; Design Studio.

governmental and civic buildings[12]. Consequently, a disconnection had been initiated between learners, or the future architects, and the surrounding society as they dealt with no real clients, a non-social demand, and an unknown contractor or builder which finally caused to have a dismissive attitude toward the eventual users. All these factors transformed the main role of architecture from shaping the human demands and activities into forms and spaces to be forming the functional program within a prototypical agenda of forms and shapes.

Figure 5: The Baux Arts; the school building, a photo of the studio and a student's sketch for a classical element.
Wallace, Natasha; Ecole des Beaux-Arts, online web site

This model of education asserted the institutions controlling on the architectural field at the expense of the practitioners control. These made the august members of the École functioned as priests. They defined what good architecture was and who good architects were[13]. Their power was extraordinary and unlimited as they were the public and revered face of the field. They constructed a monopoly over the valorization of the field's symbolic capital.

This model of architectural education made a great separation between education and practice. It also had evacuated the "Architecture"

[12] Ibid.

[13] Stevens, Garry; a brief history of architectural education, an online essay, http://www.archsoc.com/kcas/Historyed.html accessed 09/05/2004

definition from its social side and as a result, students rarely took design beyond the schematic design phase, paid little attention to construction detailing or technology, and focused on the prototypical nature of the work.[14]

Practitioners criticized and described this model of teaching, which they called the studio system, as:

> *"A fantasy world in which incompetent professors who are the centre of petty personality cults encourage bizarrely unrealistic expectations in students, while avoiding the teaching of anything actually to do with the hard realities of life."*[15]

The school was split off after the student riots of 1968[16] but its effect on the architectural education lasts until the current days as their studio system for educating architecture became the backbone of most of the contemporary architectural educational systems.

2-2-2-The "Bauhaus" model:

Starting from the 18th century, and continued through the 19th century, dramatic changes had occurred in the European societies because of the "Industrial Revolution". Industrialization as a process not only caused changes in economics or social activities but also had its effects on the intellectual activities. It caused a new form of philosophical change, or a different attitude in the perception of nature[17]. Consequently, changes occurred in the social evaluation of handcraft techniques and applied arts which caused them to erode as the main concentration was towards mass production and economic factors. This motivated some artisans to search for craft techniques without migrating away the "Industrialization" principals.

The British artist William Morris started the way. From 1861 onward he initiated a reform movement aimed at fighting the damage incurred on culture by industrialization. This reform wave started to spread out in Germany later where industrialization only set in after the foundation of the Reich in 1871. In 1907, the School of Arts and Crafts had been founded in Weimar and it paved the way for the "Bauhaus" existence[18].

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[14] Fisher, Thomas; Design Studio.

[15] Stevens, Garry; a brief history of architectural education.

[16] Wallace, Natasha; Ecole des Beaux-Arts, online web site
http://www.jssgallery.org/Essay/Ecole_des_Beaux-Arts/Ecole_des_Beaux-Arts.htm
accessed 09/08/2004

[17] Industrialisation, Wikipedia, the free encyclopedia, online encyclopedia
http://en.wikipedia.org/wiki/Industrialization accessed 04/06/2005

[18] Prehistory, bauhaus-archiv, museum of design, an online website
http://www.bauhaus.de/english/bauhaus1919/vorgeschichte1919.htm accessed 05/31/2005

In 1919, Walter Gropius merged the School of Arts and Crafts with the Weimar Art Academy to form a new school for architecture and crafts called "Bauhaus". The school aimed at integrating art and economics, and to add an element of engineering to art. Students there were trained by both an artist and a master craftsman, to ensure that"

> *"Modern artists familiar with science and economics, [that] began to unite creative imagination with a practical knowledge of craftsmanship, and thus to develop a new sense of functional design,"*[19]

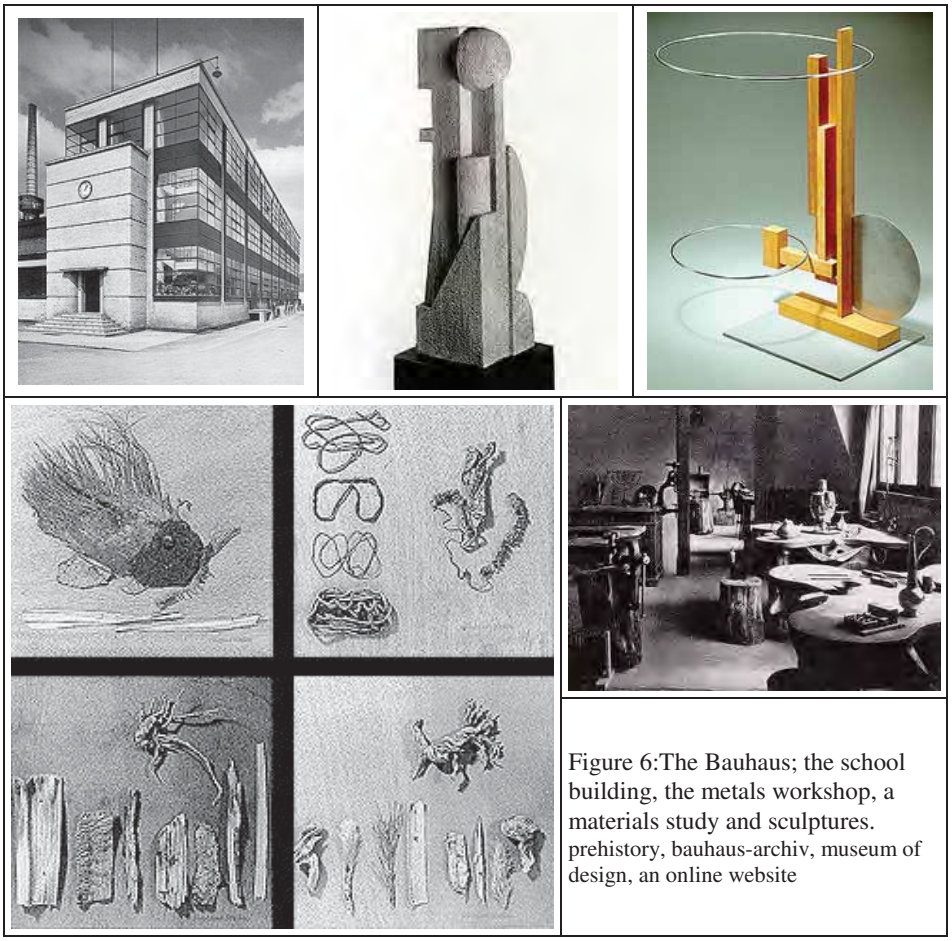

Figure 6:The Bauhaus; the school building, the metals workshop, a materials study and sculptures.
prehistory, bauhaus-archiv, museum of design, an online website

According to the Bauhaus model of teaching, machine was considered a positive element, and therefore industrial and product design were important components. Also, everything was supposed to be designed and

[19] Ibid.

created according to first principles rather than by following precedent, consequently there was no teaching of history in the school[20].

One of the main characteristics that differentiates the "Bauhaus" model than the "Beaux Arts" model is that the first concerned about how their designed could be produced. This is why students of the "Bauhaus" had to work directly with the forms they created and the materials used for making these forms[21]. The Bauhaus shaped a new architect character that assembled the power of the design decisions through the understanding of form, materials, construction and economics[22].

In 1933, The Nazi regime closed the school as they considered it a front for communists, especially because many Russian artists, like Wassily Kandinsky, were involved with it[23]. Although the Bauhaus existence did not remain for a long time comparing with the Beaux Arts, its influence is clear where the initial course content of many contemporary architectural education systems is based upon their similar one in the Bauhaus[24].

Many of the Bauhaus teachers migrated to the United States, which initiated the third turning point in the architectural education history.

2-2-3-The American model:

Through the 19th century all Americans looked to Europe as a standard so they migrated to Europe, asking for knowledge considered the crucible where science is cultivated. Of course, architecture was one of sciences that Americans searched for in Europe and naturally their eyes settled on the prestigious Ecole des Beaux Arts in Paris as the ultimate in architectural training[25]. As many Americans graduated from the Ecole and returned to the U.S., they imported the philosophies to the first American schools, such as MIT and Columbia University. By the turn of the 20th-century, most schools had Beaux Arts-trained professors, and the pedagogies of the Ecole were dominant[26].

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[20] Bauhaus, Wikipedia, the free encyclopedia, online encyclopedia http://en.wikipedia.org/wiki/Bauhaus accessed 31/05/2005

[21] al-Asad, Mobmnmad; Exploring the Cube: Experiments in the Teaching of Architectural Design, in Ashraf M. A. (ed.), Architectural Education Today; Cross-Cultural Perspectives, Lausartne, 2002, p110 http://archnet.org/library/pubdownloader/pdf/8521/doc/DPC1197.pdf accessed 27/10/2004

[22] Salama, Ashraf; New Trends in Architectural Education, Designing the Design Studio, Tailored Text, Raleigh, North Carolina, USA, 1995, p48

[23] Bauhaus, Wikipedia, the free encyclopedia.

[24] Ibid.

[25] Architectural education, the official website of the Association of Collegiate Schools of Architecture (ACSA), http://www.acsa-arch.org/architecturalEd.html accessed 09/05/2004

[26] The Redesign of Studio Culture.

Starting from the beginning of the 20th century the United States was developing a culture of its own and building up its independent identity. While the "Modern" movement in architecture was growing up in Europe, a counterpart change in architectural concepts aroused in the United States which was represented by the growing fame of the Chicago skyscraper idiom and Frank Lloyd Wright's "Prairie School" for architecture[27]. Because of the migration of German teachers from Germany to the US after the Bauhaus close in 1933, the influence of Beaux Arts model of architectural education had eroded and the Bauhaus model started to replace it. As of that changing point, the American model of architectural education started to shape its identity with more emphasis placed on the social needs.

In the 1960's a general awareness of professions social responsibilities had aroused. Architecture, as one of these professions, began to provide architectural and planning services for the disadvantaged, usually in urban areas. Those social activities had been practiced through the Community Design Centers or the CDCs, which gave rise to the "clinic" notion, which was a logical extension of the original CDC. The clinic may be in a school of architecture or exists as a separate, but related, institution. Normally it is staffed by members of a school faculty and provides students an opportunity to work on "real" projects with "real" clients, often with local architects[28].

Although the American model was basically based upon the French model or the German model of architectural education, there were significant differentiations between the three models. For the Beaux Arts model, the architectural education was dominated by the state and it was directed to serve the governmental needs. This caused a separation between teaching and practice as students had been isolated from the practice field and they were not asked to put in consideration how and for whom their concepts would be built. On the other hand, the Bauhaus model was mainly dominated by practitioners. This made the model focused, in the first place, on the production ability of the design. Issues like feasibility, mass production ability and physical needs were put in the first place. As for the American model, the architectural education was dominated mainly by universities. Consequently, the model focused on the social issues as universities were mainly dedicated to fulfilling the social needs. This is why activities like the CDCs characterized the American model than both the French and the German models of architectural education.

The previously mentioned models represent three different approaches of architectural education, each of them has its own aims. These

[27] (ACSA) Architectural education.

[28] Ibid.

aims developed over time because of changes of social demands and profession awareness of social responsibilities. Currently, contemporary societies needs and social awareness of architect's role have developed and become more complicated. This reshapes the definition and aims of the current architectural education according to the specialists, practitioners, educators and theoreticians viewpoints. That will be examined as follows.

3-The Contemporary Architectural Education Needs:

Literature review points out many issues pertaining to how the current architectural education should be. Issues related to how architecture should be taught. Issues related to how architectural curriculum should be. And also issues related to the environment within which architecture education should be practiced. Although all these issues may be classified into different categories, they are weaved together to shape the successes of architectural education. One may categorize these issues into: "What to teach?", "Where to teach?", and "How to teach?"

3-1-What to teach?

To point out "what to teach" we need first to ask: why do we teach others? And why do others ask for learning?

According to theoreticians we teach others not only as a mere transformation of knowledge but also to implement changes in the patterns of behavior of a social group in the desired direction[29]. Consequently, architectural education should not only prepare students for the profession with necessary abilities and skills but it also should educate them as people aware of social realities, being able to see the problems, to find solutions, to have critical thinking, to have their own values, and so on. So, any architectural curriculum should make a balance between three aims: "knowing What", "knowing How", and "knowing Why"[30].

3-1-1-Knowing What:

These are all issues related to mere data, facts and theories. Here, taught issues are such as architectural language, presentation and rendering methods, drafting tools and techniques, color theories, building materials, construction systems and methods, architectural styles, modern technologies

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[29] Farivarsadri, Guita; A critical view on pedagogical dimension of introductory design in architectural education, Proceedings of AEE 2001- Architectural Education Exchange, Architectural Educators: Responding to Change, September 2001, Cardiff, England
http://cebe.cf.ac.uk/aee/pdfs/farivarsadrig1.pdf accessed 27/09/2004

[30] The "What", "How" and "Why" trilogy will be discussed in more details later in chapter five.

in architecture, environmental control elements and theories, architectural style principals, and other similar subjects.

3-1-2-Knowing How:

This covers all issues related to "Process" and "Theory Application". Students have to be trained "How to operate" processes such as: problem definition, program composing and analyzing, multi solution compromising, conducting research, evaluating concepts, leadership, management, team-building, communication, decision-making, negotiation, collaborative abilities, and other similar tasks. In addition, they have to "Apply" taught general theories in lectures. This knowledge is what *Peter G. Rowe* called it as "Actionable Knowledge"[31]. According to him "Actionable Knowledge" is not simply a matter of theory and practice, but it's a matter of weaved "Knowing What" and "Knowing How". In addition, he states that, professional education in design is fundamentally about providing or, more properly, conveying actionable knowledge.

3-1-3-Knowing Why:

This covers the issues that can be classified under "Appreciation". These issues are such as: personal attitudes, understanding community inclination, psychological impact of spaces and forms, appreciating others values, emotional sets or biases, suitability of particular patterns for particular human groups or geographical positions and others. The aim here is not to "Build up" student's values but it is to "Coach" the process of shaping values.

3-2-Where to teach?

Where here does not refer to the physical place but it refers to psychological environment within which students are educated, and this is what is called "Studio Culture"[32].

According to the Report of the AIAS Studio Culture Task Force a lot of concepts that are resident deep into the conventional studio culture need to be changed[33]. For example, competition attitude should be replaced with cooperation, and focusing on end products quality should be alternated to be on design process and problem definition. The myth telling that creativity in design is only a matter of talent and intuition should be corrected to be a matter of: good problem definition, good synthesis and analysis of collected data, good compromising between resources and demands, and good evaluation of suggested problem solutions. Thinking of architecture as a one

[31] Rowe, Peter G.; Professional Design Education and Practice, Architectural Education Today; p25

[32] The Redesign of Studio Culture.

[33] The **A**merican **I**nstitute of **A**rchitecture **S**tudents.

man show should be transformed to think of it as a social activity, involving countless voices and agendas; hence its success is dependent on the application of knowledge from multiple disciplines and perspectives. In other words, the studio culture should imply a hidden curriculum that implements a set of inclinations and attitudes into students indirectly[34].

3-3-How to teach?

How to teach and what to teach are interdependent. One can not ask for a curriculum encouraging the personal abilities and skills of students through a "Teacher-Centered" model of education. Also it is impossible to provide students with real life experience with totally hypothetical situations.

Theoreticians criticize the current studio system that in most cases oversimplifies many factors involved in shaping the design problem definition[35]. In addition, the current studio system in most cases cultivates students individualistic attitude, which contradicts the real life situation where architect works within teamwork[36].

This is why many ask for narrowing the gap between formal education and professional real-world practice by implementing real life situations in education[37]. In addition, they ask for integrating internships more fully into education to bring education, experience, and practice together, which results in a more cohesive learning experience[38]. Moreover, theoreticians ask for upgrading the educators role. They think of them to coach students to construct, not only to just gain, their own knowledge, strategies and values[39]. In addition, they ask for varying the viewpoints that help in shaping students awareness, appreciation and attitudes. This is why the assistance of members from other disciplines, other cultural backgrounds, other viewpoints to the problem (user, investor, owner, politician, historian, heritage protector, NGO[40] representative, citizen...), and any other

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[34] Dutton, Thomas A.; The Hidden Curriculum and The Design Studio: Toward a Critical Studio Pedagogy, in Thomas A. Dutton (ed.), Voices in Architectural Education, Bergin and Garvy, New York, 1991, p167

[35] Salama, Ashraf; Action Learning/Problem-Based Learning, online discussion in "Architectural Pedagogy and Andragogy Forum", online forum raised and moderated by Dr. Ashraf Salama, ArchNet, http://archnet.org/forum/view.tcl?message_id=19933 accessed 09/04/2004

[36] Dutton, Thomas A.; Architectural Education and Society: an interview with J. Max Bond, Jr., in Thomas A. Dutton (ed.), Voices in Architectural Education, Bergin and Garvy, New York, 1991, p87

[37] Rowe, Peter G.; Professional Design Education and Practice, p28

[38] Education policies, The American Institute of Architects (AIA) http://www.aia.org/ed_policies accessed 09/05/2004

[39] Ward, Anthony; Biculturalism and Community Design: A Model for Critical Design Education, in Thomas A. Dutton (ed.), Voices in Architectural Education, Bergin and Garvy, New York, 1991, p216.

[40] Non Governmental Organizations.

participating decision maker may be required[41]. Consequently, "Constructivist Learning Theory" becomes the main theory that forms the new teaching models used to fulfill the contemporary needs of architecture education. These models, in one way or another, may be classified as "Experiential Learning" technique.

4- Experiential Learning / Education

Experiential learning is a process for drawing learning from experience and practice. It, as a concept, raised in the deep past, about 450 B.C, when Confucius said: *"Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand."*[42]

Also in the contemporary times many theoreticians espouse the same concept. For example *John Dewey* says*:*

> *"There is an intimate and necessary relation between the processes of actual experience and education."*[43]

Moreover, according to *Keeton & Tate* viewpoints:

> *"In Experiential learning, or learning by doing, the learner is directly in touch with the realities being studied […] Either on or off-campus, experiential learning is the apparatus in which the learner is subjected to situations where he develops and assesses his critical thinking abilities, thus allowing for freedom of creative thought and preparing for a lifetime learning process"*[44]

In general, "Experiential Learning" may be defined as a process by which change and understanding can be pursued at one time. It is usually described as cyclic, with action and critical reflection taking place in turn. The reflection is used to review the previous action and to plan the next one. It is commonly done by a group of people, though sometimes individuals use it to improve their practice[45].

It's important to differentiate between four terms related to the concept of experiential learning that literature review points out. All of them are cyclic; involve action and reflection on that action, and all have learning

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[41] Radojevic, Mirjana Devetakovic; Action Learning/Problem-Based Learning.

[42] Neill, James; Experiential Learning Cycles - Overview of 9 Experiential Learning Cycle models, http://www.wilderdom.com/experiential/elc/ExperientialLearningCycle.htm accessed 07/08/2005

[43] ibid.

[44] Safey Eldeen, Heba, Experiential Learning in Undergraduate Education: Cases from Egyptian Universities, in Ashraf M. A. (ed.), Architectural Education Today; Cross-Cultural Perspectives, Lausartne, 2002, p101

[45] Dick, Bob; Action learning and action research On line essay, 1997 http://www.scu.edu.au/schools/gcm/ar/arp/actlearn.html accessed 9/26/2004

as one of their goals. These terms are; Experiential learning, Experiential Education, Action Learning, and Action Research.

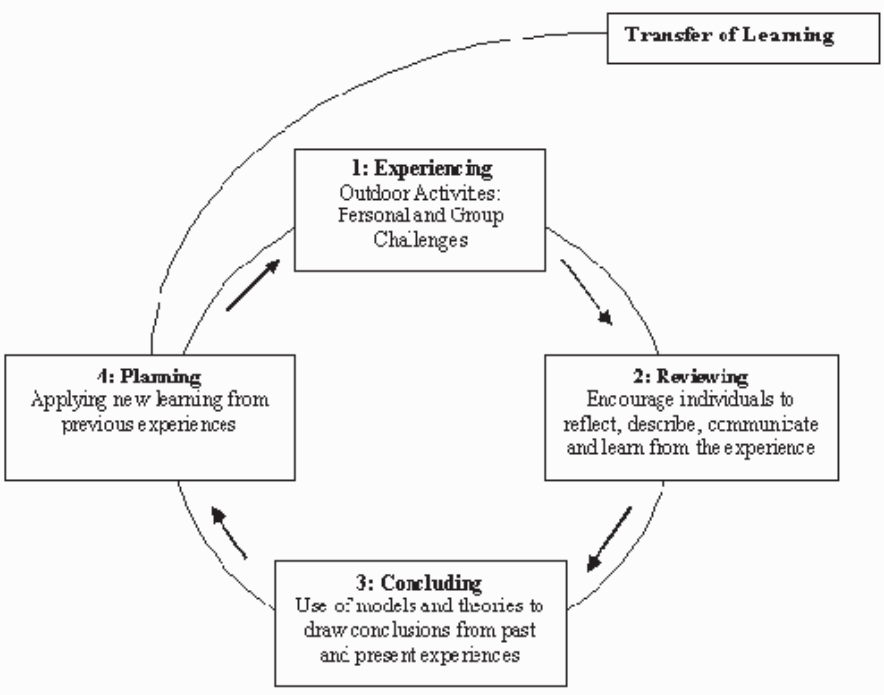

Figure 7: The Experiential Learning Cycle
Neill, James

4-1-Experiential learning:

This term refers to education that occurs as a direct participation in the events of life. It includes learning that comes about through reflection on everyday experiences. It's also known as "informal education" and includes learning that is organized by learners themselves[46]. Because of the unplanned nature of experiential learning, some experiences are educative whilst other experiences are not[47].

4-2-Experiential Education

It may be described as "Experiential learning through programs & activities structured by others"[48]. In this case an experiential educator's role is

[46] Neill, James; What is Experiential Learning, online essay.
http://www.wilderdom.com/experiential/ExperientialLearningWhatIs.html accessed 7/8/2005

[47] James Neill, Experiential Learning Cycles.

[48] James Neill, What is Experiential Learning.

to organize and facilitate direct experiences of phenomenon under the assumption that this will lead to meaningful and long lasting learning. This is contrasted with didactic education, which has "information/knowledge transmission" as the main goal. It's normal to find out that both " Experiential Education" and " Experiential learning "terms are usually used to refer to the "Experiential Education" meaning and it is nearly so rare to refer to concepts of the "Experiential Learning".[49]

4-3-Action Learning:

It's a process in which a group of people come together more or less regularly to help each other to learn from their experience. In this case participants came from different situations, where each of them was involved in different activities and faced individual problems. Consequently, each participant drew different learning from different experience.

4-4-Action research:

This is typically the "Experiential Education" and the main difference between it and the action learning is that in action research a team of people drew collective learning from a collective experience. In action research, learners draw their learning from the same change activity, all are participants in it. But in action learning, the learning and the activity in most cases are unique to each learner.

Also here, like it's in case of "Experiential Learning" and "Experiential Research", both the "Action Learning" and "Action Research" terms are used now to refer to the "Action Research" concepts.

But now, one must wonder, how far educators may depend on "Experiential Education" as a method of teaching architecture.

5-"Experiential Learning" Suitability:

Initially, it should be noted that discovery is not always the only way of learning in architecture. According to *Sprinthall and Sprinthall* there are three models of teaching: teaching through transmitting knowledge, through discovery and inductive inquiry, and through interpersonal learning. Generally all these models are used but still teaching design through "Experiential Learning" is the dominant form of design education[50].

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[49] The researcher will use the term "Experiential learning" to refer to the "experiential education" concepts as it became a normal usage.

[50] Farivarsadri, Guita; A critical view on pedagogical dimension of introductory design in architectural education, AEE2001., p6

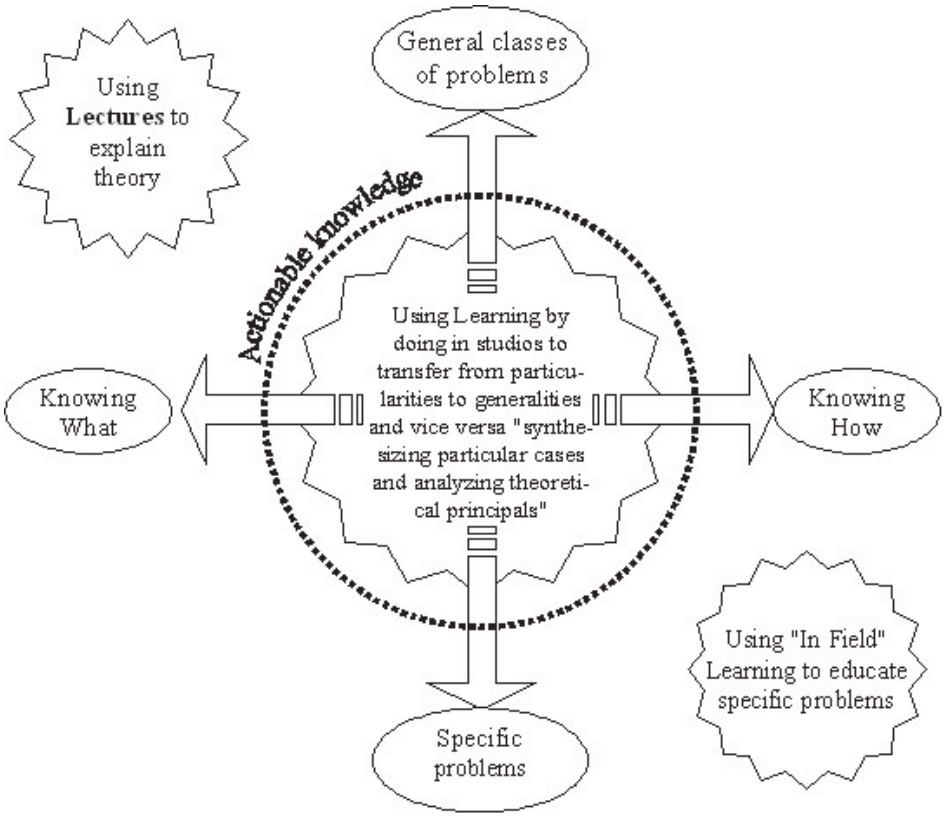

Figure 8: The educational aim versus the teaching methodology Cartesian space.
Chart created by the author based on *Peter G. Rowe*

To know when and which teaching methodology educator should use to teach students, once again "Knowing How" and "Knowing What" will arise. It is necessary to determine what he/she is intending to teach, is it a matter of "Knowing What" or "Knowing How"? Moreover, does he/she aim to teach specific cases, or instances, of problem-solving and judgment or teaching the idea of knowing about general classes of problem-solving and judgment?

These factors may be represented within Cartesian space, *see Figure 8*, where there are two main axes, one graded from 'Knowing What to 'Knowing How' and the other between specific problems to general classes of problems. Within this space, lectures, for example, lie high up on the "Knowing What" end of the scale where they can be general in scope and offer relatively complete views of a field. Studios, by contrast, usually address a specific problem or issue. Consequently, Case methods, learning by doing, and other non "Teacher-Centered" teaching models are used within

studios to bounce between particularities to generalities and vice versa. This is why studios might well be located around the center of the two axes where actionable knowledge is most likely to be delivered effectively[51].

Finally "In Field" learning is very specific and geared to what's "on the boards" at a particular moment. This is why it would be located clearly in the zone demarcated by "Knowing How" in a specific instance.

Undoubtedly Experiential learning stands here as an appropriate solution in case of "Actionable Knowledge" and "Knowing How" rather than the case of "Knowing What". But unfortunately many factors stand against fully depending on this teaching methodology.

6-"Experiential Learning" Obstacles:

Factors that hamper using the "Experiential Learning" to teach architecture may be classified into two classes; intellectual factors and technical factors.

6-1-Technical factors:

6-1-1-Time factor:

Because of the increasing number of subjects that have to be taught to architectural students, the teaching time devoted to each subject has been reduced, forcing the curriculum to be cramped and condensed[52]. And as experiential learning depends mainly on repeated cycles of action → reflection → analyzing → planning → action, this means it usually consumes much more time than "knowledge transmitting" methodology.

6-1-2-Resources factor:

In most cases, architectural departments are of the poorest ones all over other engineering departments. One finds insufficient space, inappropriate buildings, antiquated or non-existent equipment, ridiculous financing compared with the official goals, overcrowded institutions, lack of balance in geographical representation, insufficient or non-existent libraries and laboratories and many failures in diversification of institutions[53]. Consequently one can not think of technical laboratories for practicing

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[51] Rowe, Peter G.; Professional Design Education and Practice, p27

[52] Barrada, Abdel Mohsen; Training Architects: Egypt, in Ahmet Evin (ed.), Architectural Education in the Islamic World, Singapore: Concept Media/Aga Khan Award for Architecture, 1986
http://archnet.org/library/pubdownloader/pdf/2769/doc/DPC0240.pdf accessed 15/05/2005

[53] Tochtermann, Wolf; Training Architects: Some Comments, in Ahmet Evin (ed.), Architectural Education in the Islamic World, Singapore: Concept Media/Aga Khan Award for Architecture, 1986.
http://archnet.org/library/pubdownloader/pdf/2767/doc/DPC0238. pdf accessed 15/05/2005

experiments on scientific subjects related to architectural engineering such as sounds and environmental control for example. This, in most cases, obliges instructors to offer students science as a product of scientific inquiry, not examining the process that led up to this product[54].

6-1-3-"Students per Instructor" factor:

Generally, the increased numbers of students that join universities every year seriously affected the status of public higher education[55]. As architecture education depends mainly on "one to one" relation, this enlarges the problem here. For example, think of an instructor tries to coach a group of 120 students on a building site. Or another one coaches about 10 groups; each of them consists of 6 students, through a "Multidisciplinary Negotiations" simulation session.

6-1-4-"Faults Implications" factor:

As the experiential learning depends on learning from, previously made, faults, it means faults are an important educational element. However, in some cases it is impossible to allow faults happen because of their dangerous implications or their financial implications. For example think of faults implications of a wrong insulation process during a building construction.

6-2-Intellectual factors:

They are all issues related to instructors viewpoint of teaching, their inclinations, how they look towards students abilities, how they define architecture as a profession and other inclinations and doubts. In addition, issues regarding students learning abilities exist here.

6-2-1-Students intellectual factors:

One should have a clear insight into the system of education that students pass through in secondary education. In many countries, especially in the third world ones, students come to higher education from a very rigid and authoritarian educational system in secondary school, which does by no means allow for self-expression and self-confidence. In addition, there is almost no place for research, creative work, imagination, and other creative activities. The whole system is based on memorizing and preparation for

[54] Safey Eldeen, Heba; Experiential Learning in Undergraduate Education.

[55] Awad, Mohamed, Reviving the Role of the Master Builder, p83

university entrance exam, which means finding fast solutions for multi-choice solutions rather than thinking-in-depth[56].

Consequently, students are not, in most cases, prepared to go through the cycles of experiential education to get the knowledge. They are, usually, seeking to "Spoon Feed" education. This makes it hard to change their way of thinking about their role in the educational process and adopt a new learner identity. To be a learner who does not only accept, listen, and be a passive student but that one who is active participant in the educational process. This transition from receiver of knowledge to critic and constructor of knowledge is complex and hence difficult for many students to achieve[57].

6-2-2-Instructors intellectual factors:

According to many instructors, architectural education scholar years are the only chance students have to break through reality boundaries[58]. Consequently, they oversimplify many factors that are so important and vital in real life situation. They, in most cases, place no emphasis on the role that clients and users play in the design process. In most studio projects, the client and users are merely fictional characters described in the design problem handout[59].

On the other hand some instructors try to play the client's role to train students on architect-client relation, this does not give a perfect simulation. In these cases, the teacher knows more about architecture than the student, whereas in real life the situation is reversed, and the client, in general, needs to be informed. In the student's project, teacher seeks for architectural and spatial qualities of design, while the client is concerned with cost, image, time and finance, maintenance and, rarely, the architectural quality of the design. The teacher have the ability to translate student's drawings, imagine his/her concepts and see the potential of his/her premature drawings, while clients see lines on paper that are in need to be translated into a convenient language to his/her knowledge. Negotiating with clients is an art in itself and replacing real clients with instructors makes it lose its essence and gives a

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[56] Farivarsadri, Guita; A critical view on pedagogical dimension of introductory design in architectural education, p5

[57] Parnell, Rosie; It's good to talk, Managing disjunction through peer discussion, Proceedings of AEE 2001- Architectural Education Exchange, Architectural Educators: Responding to Change, September 2001, Cardiff, England.
http://ctiweb.cf.ac.uk/aee/pdfs/parnellr.pdf accessed 27/09/2004

[58] Salama, Ashraf; Action Learning/Problem-Based Learning.

[59] Farivarsadri, Guita; A critical view on pedagogical dimension of introductory design in architectural education, p11

poor simulation of the real life situation[60]. Consequently, as experiential learning success depends mainly on the real life, or at least perfect simulated real life, situations, most of instructors who pretend to use real life situation as an educational tool truly do not.

7-Chapter Two Summary:

As a conclusion of the architectural education investigation, these concepts may be pointed:

1. Architecture as a subject and profession supported on main three pivots neither of them can be oversimplified nor marginalized; Arts, Science, and Humans.
2. Architectural education is not a still matter; it's a changeable subject. Its definition, aims, contents, and teaching methodologies change dramatically according to its contemporary social needs and inclinations.
3. Although it was the oldest teaching methodology of architecture but the guild system proved that it was the most effective one as it evolved from the heart of the surrounding society which guarantee the continuity of architect- society relation.
4. The American model may be considered as the first one of the contemporary teaching models of architecture that tried to connect again between architecture as an art, architecture as a profession and architecture as a human activity. This maximized, again, the social role of architects.
5. Contemporary architecture education should balance between "Knowing What", "Knowing How" and "Knowing Why" as they are the main three components of any successful education.
6. Contemporary architecture education should prepare students to face real life situations and their complexity. This means it is essential to avoid, while teaching architecture, oversimplifying important factors that are vital in reality.
7. Although experiential learning is one of the best teaching models that are classified under the "constructivist learning theory", it is not used widely in contemporary architecture education because of many factors, technical and intellectual, hampering its usage.

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[60] Alamuddin, Hana; “I Want a Colonial House” The Architect versus the Other, in Ashraf M. A. (ed.), Architectural Education Today; Cross-Cultural Perspectives, Lausartne, 2002, p73
http://archnet.org/library/pubdownloader/pdf/8521/doc/DPC1197.pdf Accessed 27/10/2004

Now, after investigating the architectural education realm one may assume that:

1. One of the most suitable approaches that may solve much of the contemporary needs of architectural education is to depend on the experiential learning concepts or any other teaching model that is classified under the constructivist learning theory.
2. It is an essential need to try to find a way to reinvent the benefits of the guild system architectural education where students have a direct contact with the real environment and learn by experiencing the real life problems and through making mistakes and finding out how they can correct them.
3. Architectural educators should give up playing the client role as they will never do it faithfully. This is because their architectural background will always affect their comments and criticism of the student's work. This is exactly different from the case of the real client where his criticism is based on other values like economics, time factor and others. We need to find an honest replacement of the client; thinks like he does and patient like the teacher is.
4. It is important to search for a solution for overcoming the technical factors that hamper experiential learning usage in order to pave the way for overcoming the intellectual factors. This is why it was thought to examine the digital technology field and its applications for a solution because of its contemporary effective existence in the field of education. And this is what will be discussed under the next chapter.

3- Chapter Three: Digital Technology Involvement in Education

"Computers are changing our world: how we work… how we shop… how we entertain ourselves… how we communicate… how we engage in politics… how we care for our health…. The list goes on and on. But will computers change the way we learn?"[1]

[1] Shaffer, David Williamson; Squire, Kurt R.; Halverson, Richard; Gee, James P. ; Video games and the future of learning, Wisconsin Center for Education Research, Working Paper No. 2005-4, School of Education, University of Wisconsin, Madison, June 2005
http://www.academiccolab.org/resources/gappspaper1.pdf accessed 26/12/2006

Introduction:

The previous two chapters investigated the educational realm; its theories, teaching models and definitions. In addition, the architectural education has been investigated as a specific matter of education. The research tried to find out what is meant by architectural education, what it aims at, how it can be developed. This chapter investigates how the digital technology contributes to developing the educational process. How educators use the digital technology while teaching.

In addition, through this investigation, it will be convenient to step forward towards the games realm as a main branch of the contemporary digital technology. "Games" will be investigated because they become a pressing matter involved deeply in the educational realm. One needs to find the academic description of the term "Game", to find out its rooting history, to differentiate between games and kids play, to know how to differentiate between games and other digital software such as models and simulators. This chapter will address these issues by finding answers to:

- How digital technology may be involved in the educational process?
- What are the main forms of Computer Based Education (CBE)?
- How can we define the term "Games"?
- What are the different classes, and their characteristics of games?
- What are the differences between games, simulators and models?

1-Digital Technology Involvement in Education:

Personal Computers were first used in 1981 when the IBM was the first mainframe manufacturer to develop a PC. With this type of PC, simple educational applications, such as drill and practice ones, gained acceptance in education. In 1984, many companies started to develop some computer-based educational applications for commercial sales. Currently, Computer-Based Education (CBE) applications are more popular than ever in the educational system[2]. This wide usage of computers in the educational process introduced a set of various terms to describe various involvements of computers into the educational process. In the coming section the research will try to use the most frequently used terms to identify how much the computer involvement in the educational process is. These terms are[3]:

[2] Häkkinen, P, Challenges for design of computer-based learning environments, British Journal of Educational Technology, Vol.33, No.4, 2002, p. 465

[3] Cotton, Kathleen; Computer-Assisted Instruction, School Improvement Research Series (SIRS), Series V, 1991-1992, Close-Up #10, Northwest Regional Educational Laboratory, May1991 http://www.nwrel.org/scpd/sirs/5/cu10.html accessed 08/03/2007

1-1-Computer-Based Education (CBE):

It is also called Computer-Based Instruction (CBI). This is the broadest term and can refer to any kind of computer use in educational settings either for teaching, facilitating teaching or management purpose. It may refer either to stand-alone computer learning activities or to computer activities that reinforce material introduced and taught by teachers.

1-2-Computer-Managed Instruction (CMI):

It can refer either to the use of computers by school staff to organize student data and make instructional decisions or to activities in which the computer evaluates student test performance, guides them to appropriate instructional resources, and keeps records of their progress.

1-3-Computer-Assisted Instruction (CAI):

It is a narrower term and most often refers to teaching/learning applications offered either by themselves or as supplements to traditional, teacher directed instruction. In such case, computers are used to provide course content instruction in the form of drill and practice, tutorials, simulators, and games[4].

1-3-1-Drill and practice

As the simplest form of CAI, drill-and-practice programs also were the most common. Drill-and-practice programs are not designed to teach new skills or introduce new content. It is assumed that the skill or knowledge has already been introduced and that drill gives learners the opportunity to master the material at their own pace[5]. These programs work well in increasing student knowledge through repetition, usually through questioning. Students can take as much time as they need or repeat sections, helping to individualize instruction. The advantage of drill-and-practice programs typically lies in the automatic feedback they provide to learners, relieving them from having to look up the answers in the back of the book[6].

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[4] Mafune, Patricia; The Rationale behind the use of Drills, Tutorials, Simulations and Games, master of education Project
http://hagar.up.ac.za/catts/learner/patriciam/Ratinal.html accessed 21/02/2007

[5] Ibid.

[6] Dowd, Steven B. & Bower, R., Computer-based Instruction, Teaching Techniques, V.66, No.4, 1999.
http://www.asrt.org/Media/Pdf/ForEducators/3_InstructionalTools/3.5Computer.pdf
accessed 07/03/2007

1-3-2-Tutorials

They are one of the most common types of CAI. In their simplest form, tutorials are "page-turners" similar to textbooks, interspersed with predetermined questions and responses. Tutorials that are more complicated offer analysis of the response to a question, branching and parallel sequencing of text, supplementary and remedial work and allow students to structure the work to meet their needs, rather than being specifically sequenced. The one-to-one tutoring and feedback provided by a tutorial can make it an excellent tool for improving student knowledge (cognitive domain). Some tutorials do not guide the student through the information, but only present it[7].

1-3-3-Simulators

A computer simulator attempts to reproduce real-life situations and asks the student to provide data that may alter the outcome of the process. The purpose of such activity is to help the student to build a useful mental model of part of the world and to provide an opportunity to test it safely and efficiently. In addition, simulators can bridge the gap from abstract knowledge presented in class to actual performance by letting the student learn the effect of any decision. Moreover, while dealing with a simulator, students develop concepts and skills necessary for good performance, train their higher-order synthesis and analysis skills and learn from their actions. The simulator's success depends on the teacher's blending the already-prepared simulation into the curriculum, highlighting and reinforcing the learning inherent in the game. Moreover, the teacher's ability to make the activities truly meaningful is critical and the self-instructional property of simulations is vital[8].

1-3-4-Games

An instructional game is much like a simulator, but unlike a simulator, a game does not necessarily mimic reality. Games, however, do provide the student with entertaining challenges[9].

In many cases, games and simulators are used interchangeably due to their likeness. Thus to differentiate between them, and because this is the main concern of this research, the coming section will try to investigate in much more details the games realm.

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[7] Dowd, Steven B. et. al.., Computer-based Instruction.

[8] Ibid.

[9] Mafune, Patricia; The Rationale behind the use of Drills, Tutorials, Simulations and Games.

Table [3]: differences between CAI's forms
Dowd, Steven B. & Bower, Richard, Computer-based Instruction

	Purpose	Goal	Control
Drill& Practice	Reinforce and practice content that already has been learned.	To help fix facts and concepts in the learner's mind (knowledge).	Primarily computer and author of program; additional learner control is desirable.
Tutorials	Present new content; review known material in a different format.	To acquire basic facts and concepts (knowledge).	Primarily computer and author of program; additional learner control is desirable.
Simulators	Present and manipulate a model in real life in which the student may make decisions.	To integrate skills and knowledge; to develop problem-solving skills (generic and specific); to provide insight.	Primarily learner.
Games	Provide a competitive situation with a defined outcome.	To develop insight into various strategies for reaching a defined goal; to provide "fun" in learning.	Primarily learner.

2-"Games" Definition:

Searching dictionaries for the linguistic definition of the term "Game" gives a set of meanings like[10]:

- Activity engaged in for diversion or amusement
- A procedure or strategy for gaining an end
- A physical or mental competition conducted according to rules with the participants in direct opposition to each other
- Any activity undertaken or regarded as a contest involving rivalry, strategy, or struggle.

Nevertheless, is it a sufficient definition? Many researchers wrote about the term "game" and how they see it and according to their writings, "Game" is much more than a simple word. According to *Tara McPherson*[11]:

> *"Is a powerful cultural force along other registers, a force which ripples across diverse on- and offline spaces, modeling new modes of experience and of interactivity."*

[10] Merriam-Webster Online Dictionary
http://www.m-w.com/dictionary/game accessed 20/01/2007

[11] McPherson, Tara; Patched In; A Conversation with Anne-Marie Schleiner about Computer Gaming Culture, the Electronic Book Review
http://www.electronicbookreview.com/v3/servlet/ebr?essay_id=mcphersonaltx&command=view_essa accessed 08/14/2004

On the other hand, *Parlett*[12] cares about differentiating between informal games or what can be called "kids play and tumbling" and formal games, which has explicit ends and means. According to him, games are a contest based around the completion of an end, and achieving this is called "Winning the game". Therefore, by definition a formal game should have a winner and this is not the must case in kids playing and tumbling.

Chris Crawford states that[13]:

> *"A game is a closed formal system that subjectively represents a subset of reality. (**Closed**) means that the game is complete and self sufficient as a structure. The model world created by the game is internally complete; no reference need be made to agents outside of the game. […] it is closed because the rules cover all contingencies encountered in the game. (**Formal**), means only that the game has explicit rules. (**System**) […] refers to the game's collection of parts that interact with each other, often in complex ways. (**Subjectively represents**): Representation is a coin with two faces: an objective face and a subjective face. […] In a game, these two faces are intertwined, with emphasis on the subjective face. Thus, a game represents something from subjective reality, not objective. Games are objectively unreal in that they do not physically recreate the situations they represent. A game creates a fantasy representation, not a scientific model. (**Subset of reality**): Clearly, no game could include all of reality without being reality itself; thus, a game must be at most a subset of reality. The choice of matter in the subset is the means of providing focus to the game.*

In addition, architects had their point of view toward games that are used in design field. *Henry Sanoff* states that[14]:

> *Gaming is an approach to problem solving that engages a real life situation compressed in time so that the essential characteristics of the problem are open to examination. This technique is particularity appealing for designers because it*

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[12] Björk, Staffan; Holopainen, Jussi; Describing Games; An Interaction-Centric Structural Framework, In Copier, M. & Raessens, J. (ed.) (2003) Level Up - CD-ROM Proceedings of Digital Games Research Conference 2003, Utrecht, The Netherlands, November 2003
www.tii.se/play/publications/2003/structuralframework.pdf accessed 15/12/2006

[13] Crawford, Chris; The Art of Computer Game Design, 1996-7 Washington State University, an electronic reproduction of an out printed paper book with the same name of the same author, page 7
http://www.mindsim.com/MindSim/Corporate/artCGD.pdf accessed 21/09/2006

[14] Sanoff, Henry; Design Games, experimental edition, William Kaufmann, inc., California, 1979, p. 1

permits learning about the process of change in a dynamic environment requiring periodic decisions.

Ashraf Salama also defined design games as[15]:
"Games are simple constructs involving interaction among a group of people to reflect a "real world" situation. Design Games are devised to abstract the essential characteristics of a design situation. They are not about who wins and who loses; they are about group discussion to reach consensus decisions."

"The objective of those games is to develop students or users thinking abilities in contingent situations by introducing "What If" scenarios"

Although there are many attempts and views on defining the term "Game", one can draw out the main connecting points between all these definitions. One may state that "Game" is a term used to describe a human activity that is yield to a set of rules which are well known and agreed between participants. In some cases, the game represents a simulation of a real life situation but with abstraction and dropping of unnecessary elements according to the game rules and aim. Moreover, any game has its end that is the participants aim at and this end, which is called the winning state, is the main participation motivator in such activity. Winning, by nature, is accompanied by losing as the other face of the coin. This means gaming is equal to competing but it may also depend on cooperation to achieve winning and in such cases, there will be no losers. To explain this contradiction it is a must first to explain that it is not necessary to compete against humans to be playing a game. It is also a game to try to swim against the water stream direction without other competitors, and it is a winning state to cooperate with others to manage the local resources of your community to develop it. In such cases, there are no winners that are accompanied with losers. It is a case of "all win" or "all lose". Finally, games in general have their entertainment nature although some of them are serious enough to be considered as a job, such as the case in *Henry Sanoff*'s Design Games.

3-Games Classification and Characteristics:

Many organizations and/or researchers have developed classifications for the games realm. In most cases, these taxonomies and classifications are

[15] Salama, A.; Action Learning/Problem-Based Learning, An online discussion, Architectural Pedagogy and Andragogy Forum, an online forum raised and directed by Dr. Ashraf Salama on the ArchNet Website "a website dedicated in Islamic architecture issues"
http://archnet.org/forum/view.tcl?message_id=19933 accessed 09/04/2004

based on how these organizations or researchers are interested in the games realm and how they deal with them.

3-1-Organizations classifications:

In case of the organizations that are interested in the games realm for the consumers and industry sake, there are different taxonomies that serve for different specified issue. Mainly one may categorize these taxonomies into to classes; one serves the players sake and the other serves the players parents sake.

Table [4]: NPD's games realm taxonomy
Pagulayan, R. J et al.

Category	**Description**
Action	To control a character and achieve one or more objectives with it.
Fighting	To defeat an opponent in virtual physical combat.
Racing	To complete a course before others do and/or accumulate more points than others while completing a course.
Shooters	To shoot as many things as possible and to avoid shooting other things (1st person shooters, 3rd person shooters).
Simulations	To effectively control something that mimics behavior in the real world.
Strategy/RPG	To defeat an opponent using a large and sophisticated array of elements.
Family entertainment	To interact with others and/or to solve problems.
Children's entertainment	Same as family entertainment but geared to a younger audience.
Edutainment	Primarily training systems that incorporate some elements of fun into their training regimen.
Sports	Player manages a team or plays a position, the objective is either to manage your team well or to win a game a rack up impressive stats.

3-1-1-Player-oriented taxonomies:

This taxonomy serves the buyers needs for differentiating between games types to know how would be the game they attend to buy. For

example, the NPD group[16] established a taxonomy that uses a fine-grained classification scheme for game type that is referred to quite often in the games industry[17]. This taxonomy is presented in *Table [4]*

3-1-2-Parents-oriented taxonomies:

This one also serves mainly the consumers but it does so by classifying games according to their content suitability for different ages. It declares, according to their iconic classification, if it is suitable for kids, teenagers, adults, and so on. An example is the taxonomy which has been established by *Entertainment Software Rating Board* (ESRB)[18] that is represented in *Table [5].*

3-2-Academies classifications:

On the other hand there are, also, taxonomies that researchers established according to their academic researches. In most cases, these taxonomies are based on the psychological effects of games and their effect on the mental/physical abilities of the players. The major two taxonomies are the ones established by "*Caillois*" and "*Crawford*".

3-2-1-Caillois taxonomy:

In his book 'Man, Play and Games, *Caillois* classifies the games realm into four main categories that describe the main characteristics of the game: games of chance, competition, simulation and vertigo[19]. Although the taxonomy is firstly made for the formal, "non digital" games, it is still valid for digital ones.

Games of chance

Comprise all games that are based on a decision independent of the player, and winning is the result of fate rather than being better/smarter than an opponent. In this type of games, the player is passive and does not make

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[16] A leading global market research company, formerly "*National Purchase Diary"*, founded in 1967 and provides consumer and retail information to manufacturers and retailers. The Wikipedia, the free encyclopedia.
http://en.wikipedia.org/wiki/NPD_Group#_note-0 accessed 31/08/2007

[17] Pagulayan, R. J.; Keeker, K.; Wixon, D.; Romero, R.; & Fuller, T.; User-centered design in games, In J. Jacko and A. Sears (ed.), Handbook for Human-Computer Interaction in Interactive Systems (pp. 883-906). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.2003.
www.microsoft.com/playtest/Publications/User Centered Game Design.doc accessed 18/09/2006

[18] Entertainment Software Rating Board, http://www.esrb.org/index-js.jsp accessed 06/12/2006

[19] Fihlo, J. Cabral; Formal games and interactive design: computers as formal devices for informal interaction between clients and architects, school of architectural studies, Sheffield University, PhD. Thesis, 1996.
http://www.arq.ufmg.br/lagear/cabral/phd/ accessed 15/1/2007

any mental/physical effort. Hence, in this type of games there is no need for experience, training or use of intelligence or special skills. Examples of these games are: roulette, dice, heads or tails, lotteries and other similar games.

Table [5]: ESRB's games realm taxonomy

	**EARLY CHILDHOOD** Titles rated EC (Early Childhood) have content that may be suitable for ages 3 and older. Contains no material that parents would find inappropriate.
	**EVERYONE** Titles rated E (Everyone) have content that may be suitable for ages 6 and older. Titles in this category may contain minimal cartoon, fantasy or mild violence and/or infrequent use of mild language.
	**EVERYONE 10+** Titles rated E10+ (Everyone 10 and older) have content that may be suitable for ages 10 and older. Titles in this category may contain more cartoon, fantasy or mild violence, mild language and/or minimal suggestive themes.
	**TEEN** Titles rated T (Teen) have content that may be suitable for ages 13 and older. Titles in this category may contain violence, suggestive themes, crude humor, minimal blood, simulated gambling, and/or infrequent use of strong language.
	**MATURE** Titles rated M (Mature) have content that may be suitable for persons ages 17 and older. Titles in this category may contain intense violence, blood and gore, sexual content and/or strong language.
	**ADULTS ONLY** Titles rated AO (Adults Only) have content that should only be played by persons 18 years and older. Titles in this category may include prolonged scenes of intense violence and/or graphic sexual content and nudity.
	**RATING PENDING** Titles listed as RP (Rating Pending) have been submitted to the ESRB and are awaiting final rating. (This symbol appears only in advertising prior to a game's release.)

Games of competition

Games of competition rely on competing against another opponent either it is artificial or real within a context of artificial equality. In this game category, the player totally depends on his/her own abilities and skills to overcome his/her opponent and to show his/her superiority in one, or more, specific issue such as speed, endurance, strength, memory, skill, etc. Contrary to games of chance, the practice of competition games presupposes sustained attention, appropriate training, and assiduous application. Moreover, frequent playing with such games develops the player's abilities and skills that are used while playing the game. Examples of these games are: chess, checkers, boxing, tennis and other similar games.

Games of simulation

In this games category, players create an imaginary universe and see themselves as someone else. In games of simulation, illusion plays a great part: player and audience have a pact to believe that something is real, even if they know for sure it is not real. Role playing games are the most popular examples of these games.

Games of vertigo

These games aim to impose a disorder in the bodily senses. Players "*attempt to momentarily destroy the stability of perception and inflict a kind of voluptuous panic upon an otherwise lucid mind*." Examples of these games are the swings, slides and other similar games.

3-2-2-Crawford's taxonomy:

Chris Crawford[20] classified games into two main categories according to the skills demanded from the player. According to *Crawford's* taxonomy, games are divided into two broad categories: "Skill-and-Action" (S&A) games and "Strategy" games and each of them have its own subcategories.

Skill-and-Action games

These are all games that involve and emphasize player's perceptual and motor skills. The primary skills demanded of the player are hand-eye coordination and fast reaction time. *Crawford* grouped these games into six subcategories:

- Combat Games: they present a direct, violent confrontation where the human player must shoot and destroy the bad guys controlled by the computer.
- Maze Games: they are characterized by the maze of paths through which the player must move to achieve his/her goal.

[20]Crawford, Chris; The Art of Computer Game Design, pages 25-35

- Sports Games: which simulate the real sport games like football, basket ball, golf and other similar games.
- Paddle Games: this term is used to cover the PONG-based games where the player controls a paddle to bounce a ball as much time as he/she can to gain more points.
- Race Games: where the player tries to be the first to reach the end line through a race between human or computer controlled characters, cars, motorcycles and other similar games.
- Miscellaneous Games: these are some games that may be classified as S&A games but still can not fit into any of the above 5 subcategories.

Strategy games:

These games emphasize cogitation and mental skills rather than manipulation and physical skills. No doubt that some S&A games do indeed have a strategic element but the major distinguishing factor between strategy games and S&A games is the emphasis on motor skills. Crawford grouped Strategy games into six subcategories:

- Adventures: In these games, the player must move through a complex world, collecting items and tools from the surrounding context and use them to overcome and solve puzzled nature obstacles to reach the final goal or destination. These games are closer to puzzles than to games, where, puzzles are distinguished from games by the static nature of the obstacles they present to the player. Adventure games do not present continuous challenge because once the player managed to solve its puzzles and riddles and reached his/her final goal, he/she loses interest in the game to play again. This type of games train players on drawing patterns and deduct relations and connections.
- D&D Games: The abbreviation comes from the classic fantasy role-playing games "Dungeons and Dragons"[21]. This kind of games compromises two types of games; the "Adventure" games and the "Combat" games. Here, both mental and physical skills are involved while playing the game. Also this type of games depends on the cooperation between players to defeat the monsters when it is hard to do it alone.

[21] [A complex non computer game of exploration, cooperation, and conflict set in a fairytale world of castles, dragons, sorcerers, and dwarves. In D&D, a group of players under the guidance of a "dungeon master" sets out to gather treasure. The game is played with a minimum of hardware; players gather around a table and use little more than a pad of paper] Crawford, Chris; The Art of Computer Game Design, page 32. To know more information about the game you may visit http://www.wizards.com/default.asp?x=dnd/whatisdnd or http://en.wikipedia.org/wiki/Dungeons_&_Dragons

- War games: playing this category of games depends on the player's mental skills of making short/long plans and tactics to achieve the end goal. Here, it is not a matter of fighting between two opponents but it is a matter of using available resources to develop the player's in-game digital abilities and make plans and tactics about how to defeat the opponent's army in a virtual combat.
- Games of Chance: although this category of games mainly depend on un controlled events of fate and luck, like using dices or picking random numbers…etc, but it still involves an amount of strategy making as the player should do a strategy for using luck shots against his/her opponent, such as the case in backgammon. One more thing, this games category is totally away of depending on physical skills, fast reactions, and eye-hand coordination.
- Educational and Children's Games: games in this set are designed with explicit educational goals in mind. Although it may use either skill and practice games or strategy games concepts but being depending on hidden pedagogical core to develop the mental/cognition state of the player classifies it under the "Strategy" games category.
- Interpersonal Games: this games category depends on the negotiation abilities of the player. It involves the player into group discussions that aim for solving a serious problem. It trains the player on the negotiation abilities, decision making process and compromising between contradictions. Crawford states that[22]:

  "[…] a class of games focuses on the relationships between individuals or groups. One such game explores gossip groups. The player exchanges gossip with up to seven other computer-controlled players. The topic of conversation is always feelings, positive or negative, expressed by one person for another. Adroit posturing increases popularity. Similar games could address corporate politics, soap-opera situations, gothic romances, international diplomacy, and espionage."

Crawford admits that his taxonomy has many flaws. He states[23]:
"This is primarily because the basis of division is not any grand principle but is instead historical happenstance. There is no fundamental reason why war games should be treated any differently than D&D games. Yet, both game systems evolved separately and are historically quite distinct. Similarly, the

[22] Crawford, Chris; The Art of Computer Game Design, page 34
[23] Ibid. page 35

creation of an educational games category is my response to the efforts of educators to create educational games."

Finally it has to be clear that although there are many games taxonomies but neither of them has managed to draw a clear permanent cut edge between its categories. Two factors are the main causes of this indefinite state. The first factor is the dynamic nature of the games realm. The digital games realm is a newborn one that is still developing and has a new jump from time to time. To cope this dynamic state, the games industry always tries to develop their products to match the latest adds in the realm. On the other hand, the second factor is the gradient nature of the digital games realm. This realm may be considered as a digital gradient color pallet. The transition from one far end to another far end passes through millions of colors that any of them has its own characteristics although it still may be classified under a certain far endpoint. According to this, although there are some games which are purely action games like "*Doom*", "*Blood*" and "*Half Life*", there are some games which are a mix between action games and strategy games such as "*Rainbow six*" and others are a mix between action games and adventure games such as "*Prince of Persia*". Moreover, some games are a mix between chance games and competition games such as "Risk". Such games can not be classified under a certain game's class as they have the characteristics of more than one class. Consequently these games lay in an intermediate zone between two categories and this state makes the transition of one class to another one passes through many other subclasses.

Although all these trials to define the term "Games" and to point out the main characteristics of the games categories, there is still a popular misusage of some terms that are used interchangeably with the term "games". These terms are "*Models*", "*Simulators*", "*Role Playing*" and "*Games*". It is clear that not every game is a simulator but is every simulator a game? Moreover, what about models, are they some sort of games or simulators or some thing else? This is what will be discussed in the coming section.

4-Differences among Models, Simulators, Role-Playing and Games:

Simulation technology exists mainly into four major forms: Models, Simulators, Role-Playing and Games[24]. Although each of them contains a certain level of simulation, they are very different from each other. To

[24] Hood, Paul; Simulation as a tool in education research and development, A Technical Paper. Council for Educational Development and Research, Washington, DC Edtalk. Eric document number ED416222, pages 4-5
http://www.eric.ed.gov/ERICDocs/data/ericdocs2/content_storage_01/0000000b/80/24/67/ac.pdf
accessed 04/01/2007

understand how this dilemma could be, the main elements of any simulation activity should be clarified first.

According to *Paul Hood*, any simulation activity depends on two main elements Fidelity/Inference and Role/Rule based structure. Based on the existence of these two elements in the simulation activity, it is possible to determine if it is a Model, a Simulator, a Role-Play, or a Game. He divides the simulation domain into four quadrants along two major axes. The vertical axis distinguishes simulation by degrees ranging from "High Fidelity/Low Inference" to "Low Fidelity/High Inference". On the other hand, the horizontal axis distinguishes simulation according to whether it depends more on "rules" or "roles" *see Figure 9*. Using these two dimensions, simulation activities may be identified into four conceptual different types:

- High fidelity – rule based (modeling)
- High fidelity – role based (simulators)
- High inference – rule based (gaming)
- High inference – role based (role-playing)

Hood describes the two axes, which he called "dimensions", as:

"Although depicted as dichotomies, each of these dimensions is better conceptualized as a continuum. There are intermediate levels of fidelity/inference possible within each type of simulation. Also some simulations may be based on mixtures of rules and roles."

He also differentiated between one-player/operator simulations from multi-players/operators simulations. In his simulation domain representation, he presented the cutting edge between the two cases as a dotted diagonal separator. He states that[25]:

"Modeling is usually a one player activity whereas role-playing almost always involves two or more players."

Now, based on this simulation domain, one can define model, simulator, role-play, and gaming as:

4-1-Model

According to *Hood's* definition[26]:

"Modeling is experimentation with physical representations of a system. We use modeling to understand systems and how components of a system interact"

[25] ibid. page 4

[26] ibid. page 4

This means that modeling deals with non-human components of a system to examine how they interact with each other. The system here may be man-controlled, such as the case of weaving machines or car engines, or nature-controlled, such as the case of solar system. Modeling is so similar to the technical programs that are used to measure and design the architectural engineering components such as HVAC, plumbing, sound systems. It is a matter of accurate mathematical equations with changeable variables. Modeling has the ability to cut down development time, reduce coasts, reveal design flaws, and increase flexibility in experiments[27].

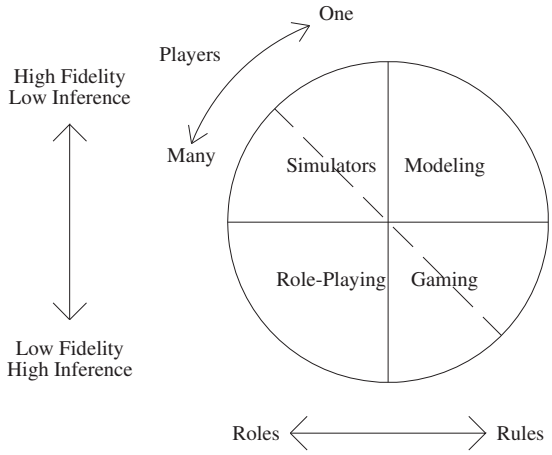

Figure 9 : Hood's domain of simulation
Hood; Paul, 1997

4-2-Simulators:

Hood defines simulators as:
"Simulators are systems in which human operators and machines interact in situations that approximate real life."

This means that the main difference between models and simulators is that in case of simulators the human being is one of the system components. He/She is not only an operator as in some cases of the model but he/she is an active involved member of the system. In general, simulators give the ability to test and validate procedures, strategies, and tactics such as the case of flight simulator.

[27] ibid. page 49

4-3-Role-Playing:

Hood states:

"Role-playing calls for participants to assume specific parts in defined social situations. It enables persons to perceive and interpret social situations and to develop and try out alternative ways to cope more effectively in interpersonal situations."

In role-playing, a player adopts someone else's personality or job and tries to act as if he/she is this one. This attitude helps to understand the viewpoint of "The Other"; what are his/her motives and supposed reactions towards specific actions. This kind of simulation is so familiar in case of studying international diplomacy and psychology. In many cases, role-playing is included into the "Simulator" especially when the simulator is going to mock up a social context or governmental system.

Prensky differentiates between the simulator and the role-play as[28]:

"Role-plays are simulations only in the most primitive sense. Simulation, as it is usually defined, involves creating a system (usually, although not always, a computer program) that reacts in a way similar to the real world, and thus teaches us about that world in the process"

It means that, unless we put the role-player into a context that reacts to his/her actions exactly as the real one, it is a "Role-Play" else, it is a "Simulator".

4-4-Games:

According to *Hood's* definition[29]:

"Gaming is formalized play with preset rules that players must follow."

This definition may cause a conflict with the role-play or the simulator. To differentiate between a game and a role-play one should differentiate between the rule-based simulation, which is a game, and the role- based simulation, which is a role-playing.

Any game is a rule-based activity where rules are prescribed guides for conduct or action. On the other hand, roles are characters assigned or

[28] Prensky, Marc; Why NOT Simulation
http://www.marcprensky.com/writing/Prensky%20-%20Why%20NOT%20Simulation.pdf
accessed 12/02/2006

[29] Hood, Paul; Simulation as a tool in education research and development, page 4

assumed and each participant performs specified roles or function within the simulation activity[30].

On the other hand, not every simulator is a game because to be a game, certain components should be contained within the activity. *Prensky* lists a number of features that supplement the characteristics of games. He assures that any activity should contain six factors to be considered as a game[31]:

1. Rules
2. Goals and Objectives
3. Outcomes and Feedback
4. Conflict / Competition / Challenge / Opposition
5. Interaction
6. Representation or Story.

He also states that[32]:

"simulations are not, in and of themselves, games – they need all the additional structural elements […] — fun, play, rules, a goal, winning, competition, etc. — to make them into [a simulation game]"

In addition, *Crawford* differentiates between Simulators and games. He states that[33]:

"A simulation is a serious attempt to accurately represent a real phenomenon in another, more malleable form. A game is an artistically simplified representation of a phenomenon."

He admits that both the simulator and the game may simplify a factor or more of the real world but:

"The simulations designer simplifies reluctantly and only as a concession to material and intellectual limitations. The game designer simplifies deliberately in order to focus the player's attention on those factors the designer judges to be important."

Moreover, he points out how are the aims of both the games and simulators are different. He states:

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[30] ibid. page 5

[31] Ahdell, Rolf & Andresen, Guttorm; Games and Simulations in Workplace E-learning: "How to Align Elearning Content with Learner Needs", Master of Science thesis, Norwegian University of Science and Technology, Department of Industrial Economics and Technology Management, 2001, page 56 http://www.twitchspeed.com/site/download/thesis_final.pdf accessed 12/02/2006

[32] Prensky, Marc; "Simulations": Are They Games?, in Marc Prensky (ed.), Digital Game-Based Learning, McGraw-Hill, 2001 http://www.marcprensky.com/writing/Prensky%20-%20Simulations-Are%20They%20Games.pdf accessed 12/02/2006

[33] Crawford, Chris; The Art of Computer Game Design, page 9

"A simulation is created for computational or evaluative purposes [on the other hand] a game is created for educational or entertainment purposes."

"A game is not merely a small simulation lacking the degree of detail that a simulation possesses; a game deliberately suppresses detail to accentuate the broader message that the designer wishes to present."

5-Chapter Three Summary:

In conclusion of the Digital technology involvement in the educational process and the games realm investigation, one may point out:

1. Starting from its emergence in 1981, computers have been used in the educational process as aiding tools.
2. Computers involvement in the educational process may be classified into two main forms; Computer Managed Instruction (CMI) and Computer Assisted Instruction (CAI).
3. The main and major forms of the CAI applications are drill and practice, tutorials, simulators, and games.
4. Gaming is not only a matter of fun and entertainment because it is, in many cases, as serious as studying and having a hard training.
5. Many activities that are called games are not more than kids playing.
6. To be truly called a game, that activity must have certain characteristics that characterize games from other activities.
7. There are many taxonomies for the games realm, but there are two main academic ones. The first classifies games according to the skills that are involved in playing the game. It classifies games into "Skill and Action" games and "Strategy" games. The other taxonomy classifies games into four classes according to the main characteristics of the game. Its classes are games of Chance, Vertigo, Simulation and Competition.
8. Although they are used interchangeably, the terms; Model, Simulator, Game and Role-Play are not the same, and their differences are due to two factors; Fidelity/ Inference factor and Role-based/Rule-based factor.

Now, after investigating the digital technology involvement in the educational process one may assume that "Gaming" could be a solution for the previously discussed needs and assumptions have pointed out in chapters

One and Two of the research. Thus, the coming chapter will address the educational games specifically.

Part Two:Games and Architectural Education

This part consists of three chapters. Chapter 4 concerns the educational games; their history, characteristics, usages, advantages, disadvantages and other related issues. Chapter 5, investigates the possibilities of using On-The-Shelf digital games as architectural educational tools. Chapter 6, draws out a conceptual framework of a proposed digital game that can be used as an educational tool for teaching/learning an architectural curriculum.

4- Chapter Four: Educational Games

"The cognitive differences of the Digital Natives cry out for new approaches to education with a better "fit." And, interestingly enough, it turns out that one of the few structures capable of meeting the Digital Natives changing learning needs and requirements is the very video and computer games they so enjoy. This is why "Digital Game-Based Learning" is beginning to emerge and thrive."[1]

"However, there is another domain with tremendous potential for reaching, motivating, and fully involving learners: The world of games. We believe that games constitute the most interactive multimedia resource in our culture today."[2]

[1] Marc Prensky, Digital Natives, Digital Immigrants part II, Do They Really Think Differently?, On the Horizon, an international quarterly publication, Vol. 9 No. 6, December 2001
http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf Accessed 8/02/2006

[2] Gros; Begoña , The impact of digital games in education, First Monday, Peer reviewed journal on the internet, volume 8, number 7, July 2003.
http://www.firstmonday.dk/issues/issue8_7/xyzgros/ Accessed 18/01/2006

Introduction:

Part one of this research tried to investigate the realm of education in general and the architectural education in particular. In addition, how the contemporary modern technology has involved in developing the educational process has been investigated. Part two will address "Educational Games" showing how they have started to involve deeply in the educational realm. One needs to find out their history, to know their distinguished characteristics, to see how others used, and are still trying to use them in serious matters rather than just entertainment. This chapter will address these issues by finding answers to the following questions:

- When was the first use of educational games as learning tools?
- Why do we use games as educational tools?
- What can games offer?
- What are the major characteristics of educational games?
- Why do some educators oppose to using games in the teaching process?
- In which teaching fields were games used successfully?

1-History of Educational Games

Using games as a vehicle for education may be considered the most ancient and time-honored educational tool. They may be considered as the natural tool that the living beings used to educate their newborn generations. *Crawford* explains that[3]:

> *A trip to the zoo will suffice. There we find two lion cubs wrestling near their mother. They growl and claw at each other. They bite and kick. One cub wanders off and notices a butterfly. It crouches in the grass, creeps over so slowly toward its insect prey, then raises its haunches, wiggles them, and pounces. […] these cubs do indeed appear to be playing a kind of game. We can certainly see in their behavior all four of the fundamental game attributes: representation, interaction, conflict, and safety. […] These games are deadly serious business. They are studying the skills of hunting, the skills of survival. They are learning how to approach their prey without being seen, how to pounce, and how to grapple with and dispatch prey without being injured. They are learning by doing, but in a safe way.*

Gradually, games began to take a serious position in the civilizations developing history. By the end of the 19th century, versions of a miniature war

[3] Crawford, Chris; The Art of Computer Game Design, page 16

game, *Kriegspiel*, were widely used in military training across Europe[4]. At the beginning of the 20th century *John Dewey*'s influence caused games to play a major role in the teaching methodology[5].

In the early 1960s, *James Coleman* and colleagues at Johns Hopkins University employed social simulation games to advance social theory and improve education practice. In 1964, *Richard Duke* designed a game called "Metropolis" for the city of Lansing, Michigan. The game used role-playing to work through cycles of policymaking, employing computers to track the effects on resources as the group went through one cycle of decision-making to another[6]. By the end of the 20th century, about 1990, a new term has been coined which is "Edutainment". This term is a portmanteau that expresses the union between education and entertainment in a television program, game or website[7].

Generally, the end of the 20th century represents a major shift in the realm of education as many voices called for new methodologies and tools that are more suitable for the new mentality, abilities and interests of new generations which have been greatly affected by the digital era. This is what will be discussed in the coming section.

2-New Generations Abilities

Nowadays, and from about a decade ago, children are growing up surrounded by a digital context. They are now using digital technology in every life matter. They are surrounded by satellite channels, cell phones, PCs, laptops, palm PCs, MP3 players, digital cameras, and other digital tools. They spend in front of screen monitors much more time than they do in front of a TV screen or a book. *Prensky* states that[8]:

> *"Today's average college grads have spent less than 5,000 hours of their lives reading, but over 10,000 hours playing video games (not to mention 20,000 hours watching TV). Computer games, email, the Internet, cell phones and instant messaging are integral parts of their lives."*

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[4] Hood, Paul; Simulation as a tool in education research and development, p. 21
http://www.eric.ed.gov/ERICDocs/data/ericdocs2/content_storage_01/0000000b/80/24/67/ac.pdf
accessed 04/01/2007

[5] Gros, Begoña; The impact of digital games in education.

[6] Hood, Paul; Simulation as a tool in education research and development, page 23

[7] Wikipedia, the free encyclopedia
http://en.wikipedia.org/wiki/Edutainment accessed 07/12/2004

[8] Prensky, Marc; Digital Natives, Digital Immigrants, On the Horizon, an international quarterly publication, Vol. 9 No. 5, October 2001
http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf accessed 08/02/2006

Such developments caused a great shift in their attitudes. For instance, take the digital cameras as an example. In the past, using optical cameras needed a certain amount of professionalism to get a good shot. In addition, results will not be developed until a certain amount of time which is, in the best case, about 20 seconds and may be stretched to be a day or two in the ordinary case. More over, there was no chance for trial and error as it costs money and time to develop the shots. Hence, getting an unsatisfying result means losing much money and time. However, with the digital cameras, one gets the chance to have as many pictures as the camera's memory card can store. In addition, results are instant which means one may try many times until one gets a satisfactory shot. Also, through this cycle of trial and error one learns how to deal with the camera abilities and how to photograph without extra cost and in few seconds. This is why we talk about a generation that hates to "Be Told" how to do something. This generation loves to "Try" to do some thing and "Examine" their trials outcomes.

In general, the "mind alterations" or "cognitive changes" caused by the new digital technologies and media caused new abilities and needs of the younger generation[9]. They are used to receiving information fast, processing in parallel rather than in serial. They prefer the graphical representation rather than the text one. They prefer random access, like hypertext, rather than "Step by Step" information construction. They function best when networked and thrive on instant gratification and frequent rewards. They prefer games to “serious” work[10].

One more important thing, this generation lives into an information context. In their homes, children and youth now have as immediate access to information as do the most erudite scholars in the world's best libraries. Science, literature, history, drama and the arts are all at their fingertips[11]. This caused a serious shift in their attitude. Now they do not need who, only, tells data, they need who coaches them while they search for and use data. This is why students loose interest and engagement when it is only a matter of knowledge transfer. Moreover, when students loose interest and/or engagement the educational process fails. This motivates educators to search for another form of teaching that suits the new digital era, so the digital learning environments have been evolved.

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[9] Prensky, Marc; Digital Game-Based Learning, digital version published online of the second chapter of the original book
http://www.twitchspeed.com/site/Ch2-Digital%20Game-Based%20Learning.html accessed 08/02/2006

[10] Prensky, Marc; Digital Natives, Digital Immigrants

[11] Elkind, David; The Reality of Virtual Stress, CIO Magazine, Fall/Winter 2003
http://www.cio.com/archive/092203/elkind.html?printversion=yes accessed 18/01/2006

3-The Digital Learning Environments:

Due to the technological development that has been achieved in the recent years, many educators and educational institutes tried to use digital forms in their teaching process. Many teachers turned to multimedia presentations in replace of transparencies and slides. Others used the electronic format for distributing their handouts and assignments. In addition, many teachers used the E-mail technology as a communication tool with their students. More over, many institutions used the net meeting technology as a teaching place via the cyber space in replace of the conventional lecture room. But unfortunately, in most cases these are digital teaching tools rather than digital learning environments.

For example, the official website of Harvard University is categorized under the so called "Academic Online Communities". However, these kinds of online communities are not truly interactive ones dedicated to learning. They are for; the contact information of the staff members and administration, papers E-publishing, courses catalogs, syllabi and to collect and distribute papers and grades. All these activities are not related to learning, so one cannot call this a "learning online community".

Learning online community is where expertise is shared and transferred from one to another. It is where one can search, ask, and discuss thoughts and ideas. It is where one chooses his/her own learning path and search for what satisfies his/her cognitive needs. This may be found in communities such as help forums, discussion groups, message boards and other similar forms as they share knowledge between individuals through a mutual interaction. These communities may be called "online social learning communities". *Prensky* classifies these communities into three main categories according to their learning efficiency[12]:

- At the lowest level are “free-for-all” discussions, which can be synchronous (i.e. live chats) or asynchronous. In these interactions, the typical posting is a sentence or two. There is lots of opinion, little substantiation past a random reference here and there, and little linking to anything else. In this online interaction community, there is relatively little “quality” learning value.
- A level higher than this is the listserv group. Postings in this type of forum are typically several paragraphs long. The

[12] Prensky, Marc; Not Only The Lonely implications of “social” online activities for higher education, On the Horizon, an international quarterly publication, Volume 10 No 4, December 2002. http://www.marcprensky.com/writing/Prensky%20-%20Not%20Only%20The%20Lonely%20-%20OTH%2010-4.pdf accessed 12/02/2006

discussion is typically moderated by a guest moderator, and this moderator sets the topic and responds from time to time. People take positions, and respond to each others ideas and views. Outside writings are often cited or even included. These are"serious" discussions compared to the first level. Although any one can participate, serious thought and discussion is expected. Hence, some useful learning can happen here.

- The third interactive community level is the most useful and highest in quality of all. This is the fully moderated discussion where the postings must be sent to the moderator only, who then decides what to post. The idea is that one person puts up a thought piece, and others then react. While anyone can submit, the submissions are vetted, and people get posted only if the editor allows. This type of online interactive community may be considered similar to a journal with editorial review.

The needs of these kinds of interactive learning communities made researchers look at the games forums where these community types are popular. This is why, and many other causes that will be discussed later, researchers started to think of games as a new educational environment. But firstly, the games prevalence should be addressed.

4-Games Prevalence

Many statistics have measured the games prevalence. For example, the entertainment software association has declared, according to their surveys, that 69% of American heads of households play computer or video games and 44% of the gamers are between 18 and 49 years old (*see Figure 10*). Moreover, gamers devote more than triple the amount of time spent playing games each week to exercising or playing sports, volunteering in the community, religious activities, creative endeavors, cultural activities, and reading. They declared that the average age of game player is 33 years old[13].

Another survey has been conducted on the MIT freshmen. About 650 students have been asked about their playing games activities. According to *Henry Jenkins* the survey results were[14]:

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[13] Entertainment Software Association, Essential facts about the computer and video game industry, sales, demographic and usage data, 2006
http://www.theesa.com/archives/files/Essential%20Facts%202006.pdf accessed 03/12/2006

[14] Jenkins, Henry; Game Theory, an MIT enterprise technology review, 2002
http://www.technologyreview.com/articles/02/03/wo_jenkins032902.asp?p=0 accessed 07/12/2004

"88 percent of them had played games before they were 10 years old and more than 75 percent of them were still playing games at least once a month. They were much more invested in games than in film, television or books, but they also were suspicious of their educational use"

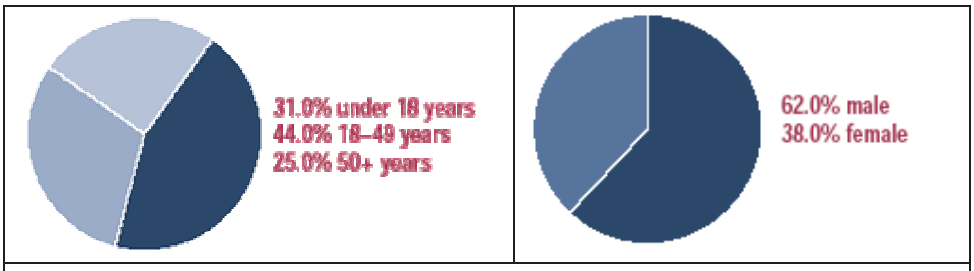

Figure 10: Entertainment software association's survey results about game players
Entertainment software association,

Based on another survey results, *Pagulayan* admits that[15]:
"The number of people in the United States who played video games during 2000 was 5 times that of those who went to America's top five amusement parks combined, and 2 times as many as those who attended all Major League Baseball games."

Also, *Tara McPherson* declares that; *"almost two-thirds of gamers now over eighteen and more than a quarter over age thirty-six"*[16]. Another study in Spain has been conducted on 3000 adolescents[17]. The study found that; 58.5 percent play almost daily, 36.7 percent play a day or two every week, and only 4.8 percent never use video games.

It is obvious that playing games is a so wide realm that it covers almost every age and both genders equally. Games are a spreading vehicle that may be accompanied by harmful or useful contents according to their designer's intents. This means if games are used correctly they may positively affect their players greatly. This raises the question: what are the games abilities? Or how can they affect their players?

5-Games Abilities:

This part of the research will investigate what games can do and offer. The research will bypass the negative side effects of the games such as

[15] Pagulayan, R. J.; et. al.

[16] McPherson, Tara; Patched In.

[17] Gros, Begoña; The impact of digital games in education

violence motivation and social isolation because many researchers still doubt these side effects and also any academic participation in the game design phase may prevent the causes of these side effects.

There are mainly two broad classes that one can classify games abilities and offers into. The first class is the psychological effect of games as a motivator and engaging factor. The other class is the games abilities as a developer of skills.

5-1-Games as an engaging environment:

The explanation of this class is exactly the causes that many prefer to play a game rather than to have a lesson. No doubt that many entertainment activities may cause engagement, but gaming is the most activity that engages the players who involve in because:

- Games are an interactive dynamic form of human activity.
- Gaming is a funny challenging activity.
- Games always have an aim, "To Win".
- Games in most cases are flexible.

5-1-1-Games engagement causes

Games interactivity:

Crawford differentiates between three classes of media/entertainment activities; static media, dynamic media and interactive media[18].

Static media depicts a snapshot of reality frozen in time. For example; a painting, a sculpture…etc are static media. Dynamic media show change with time which make them able to represent the changing aspect of reality more richly. In this class one may find; movies, music, dance, and other similar medias. Finally the interactive media represents how things react towards one's own action through time and this is what *Crawford* calls *"the intricate web work of cause and effect by which all things are tied together."* He also states that[19]:

> *"The only way to properly represent this web work is to allow the audience/ to explore its nooks and crannies to let them generate causes and observe effects. Thus, the highest and most complete form of representation is interactive representation. Games provide this interactive element, and it is a crucial factor in their appeal."*

[18] Crawford, Chris; The Art of Computer Game Design, page 9

[19] Ibid. page 9

Hence, being the moderator, not only an observer, of the actions that control the context is a backbone factor of motivating players to continue playing. Many researches find that interactivity is the most significant contributor to engagement[20].

Games funny challenging nature:

In most cases games mimic either a fantasy imagining world or a real world. In the first case, player has the chance to immerse into an imaginary world where he/she is free of the reality constrains and have the ability to be an imaginary hero. Rich visual and spatial aesthetics draw player into extravagant fantasy worlds that nevertheless seem very real on their own terms; these excite and also pleasure the player[21].

On the other hand, if the game mimics a real world it offers a challenging opportunity, free of dangerous implications, to manipulate real issues. In other words, if the real world is a world of relentless cause and effect, of tragic linkages and inevitable implications, gaming is a world where the disassociation of actions from implications is a compelling feature as the results of a game are always less harsh than the situations the game models. This is not to imply that games are devoid of implications. The penalties for losing a game can sometimes be a significant deterrent to game play[22].

Games goal:

Playing a game is not an aimless activity. Any game has its own goal which player strives to achieve. This case of acting towards a goal achievement is a motivating factor that engages player to continue playing. Also being challenged by another human/virtual opponent for achieving the game goal creates a state of caring and attention that leads to engagement. In fact, the top two reasons people say they play interactive games, according to the *Interactive Games Association*, is because they are challenging and relaxing[23]. This is true both of 'mini-games, where players achieve quick outcomes, and of complex games, such as fantasy or simulation games, which have goals and sub goals[24].

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[20] Ahdell, Rolf et. al., page 57

[21] Mitchell, Alice & Savill-Smith, Carol; The use of computer and video games for learning, a review of the literature, Learning and Skills Development Agency, 2004
www.lsda.org.uk/files/PDF/1529.pdf accessed 21/12/2006

[22] Crawford, Chris; The Art of Computer Game Design, page 14

[23] Prensky, Marc; The Motivation of Game play, On the Horizon, an international quarterly publication, Volume 10 No 1, 2002
http://www.marcprensky.com/writing/Prensky%20-%20The%20Motivation%20of%20Gameplay-OTH%2010-1.pdf accessed 12/02/2006

[24] Mitchell, Alice, et. al.; The use of computer and video games for learning

Games flexibility:

Nowadays, games have the ability to be adapted and reformed to shape particular communities and contexts. New games, in most cases, consist of a main irreplaceable game engine core which contains the essential game elements and rules and a set of plug-ins which contain the main characteristics of the game context and characters. This ability offers an opportunity of adapting the game environment to match a certain real one. This makes the player more engaged in case of he/she plays into a familiar context which may mimic his/her own one. For example, in the SimCity game there are ready made cities of famous capitals such as Paris, London and Tokyo. Also the game accepts plugging-in external maps of ready made cities to play with and moderate.

As it is clear now Games are an engaging environment and this has its major benefits.

5-1-2-Engagement effect:

In contrast to any other serious activity, being engaged to a game activity means being motivated and amused. Both of motivation and amusement are crucial factors of the learning process. Researchers state that[25]:

> *"Enjoyment and fun as part of the learning process are important when learning new tools since the learner is relaxed and motivated and therefore more willing to learn."*

Learner motivation is a key component for the success of any pedagogical activity. When one is self-motivated to do some thing this drives his/her own meta-cognitive skills, which in turn activate learning and thinking skills. This, once more, provides a feedback to the meta-cognitive skills which is enabling one's level of expertise to increase[26]. The motivation is a so important factor in the learning process where the self-motivated participants will be keen to evaluate, learn, and exercise the necessary skills and tactics required to reach the game's goals which leads to the "Wining" state.[27]

As for the fun nature of games, it provides a state of relaxation. When relaxation is accompanied with motivation, it leads to a more suitable mental

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[25] Prensky, Marc; The Motivation of Gameplay

[26] Fannon, Kate; "Needle Stick" A Role-play Simulation Transformative learning in complex dynamic social systems, Supervised Project 1 FET5660_2002S2, University of Southern Queensland. http://www3.roleplaysim.org/papers/ accessed 19/04/2004

[27] Linser, Roni & Ip, Albert; Beyond the Current E-Learning paradigm: Applications of Role Play Simulations (RPS) - case studies, In Proceedings: E-Learn 2002 World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education. 7th, Montreal, Quebec, Canada, 2002 http://www.ausis.org/SimPlay/papers/E-Learning.html accessed 19/04/2004

state for learning. On the opposite side, in case of serious issues, one may be motivated to accomplish a task successfully, but if this motivation is not accompanied with relaxation it may lead to tension and irritation which cause the learning process to fail. *Prensky* cites *"In simple terms a brain enjoying itself is functioning more efficiently."* and *"When we enjoy learning, we learn better"*[28]. Also, *Schank* presents the basic premise of learning as *"When learning isn't fun, it's not learning,"*[29]

5-2- Games as a learning environment

This section will address the games realm suitability as an environment for knowledge acquisition and skills developing. In general, skills may be classified into two main classes; soft skills and hard skills[30]. Soft skills are all mental skills such as analysis, deduction, induction, drawing mental patterns. On the other hand, hard skills are all those ones that are physical such as fast reactions, eye-hand coordination. In addition, hard skills could be practicing the use of tools, equipment or applications.

5-2-1-Developing soft skills via gaming:

As it has been explained previously, one of the games taxonomies classifies games into two main broad categories; "Skill-and-Action" games and "Strategy" games. Especially in the strategy games, player involves his/her mental abilities to achieve his/her goals. He/she makes plans and tactics, execute them, analyses the outcomes and modify his/her tactics according to his/her observations. The game here is an environment for training the mental skills of the player which causes these skills to be developed and enhanced.

Also, it has been found that playing games is an activity that helps the learning process in general. In an academic experiment *Positron Emission Tomography* (PET) scans were taken while healthy men played a video game. The scans show that, the neurotransmitter *Dopamine*, the neurotransmitter that is thought to be involved in learning, reinforcement of behavior, attention, and sensorimotor coordination, was released in the brain during play[31]. This means a much more suitable mental condition for learning.

In particular, many specified mental skills are developing while playing games. For example, the Entertainment Software Association mad an

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[28]Prensky, Marc; The Motivation of Gameplay

[29] Ahdell, Rolf et. al.; Games and simulations in workplace eLearning.

[30] Ibid.

[31] Goldstein, Jeffrey; Effects of Electronic Games on Children, march 2000, online paper http://commerce.senate.gov/hearings/0321gol.pdf accessed 08/02/2006

investigation about what skills playing games may involve and they admit that:

> *"Games require players to construct hypotheses, solve problems, develop strategies, and learn the rules of the in-game world through trial and error. Gamers must also be able to juggle several different tasks, evaluate risks and make quick decisions…. Playing games is, thus, an ideal form of preparation for the workplace of the 21st century, as some forward-thinking firms are already starting to realize."*[32]

Also, in his research about the impact of digital games in learning, *Gros* cites *McFarlane* writings about how teachers though about using games in education[33]:

> *"Most teachers acknowledge that games contribute to the development of a wide variety of strategies that are extremely important for learning: Problem-solving, sequence learning, deductive reasoning, memorizing. In addition, group strategies such as cooperative work and task-based learning can be introduced easily in the setting of a game"*

Moreover, games have the ability to develop the players divided visual attention and ability of reading images and abstracted icons. For the player's divided visual attention ability, it enhances his/her skill of keeping track of a lot of different things at the same time. On the other hand, the ability of understanding iconic or spatial representations is crucial to scientific and technical thinking. *Gros* cites *Greenfield's* research results about how games shift the representation mental ability from the verbal format to the iconic format:

> *"Another skill embodied in computer games is iconic or the ability to read images, such as pictures and diagrams." "In a cross-cultural study carried out in Rome and Los Angeles, Greenfield et al. (1994) found that playing a computer game shifted representational styles from verbal to iconic. In the study, undergraduate students played the game Concentration either on a computer or on a board. Those who had played the game on the computer used more diagrams in their descriptions of an animated computer simulation, whereas those who played the game on a board offered more verbal descriptions."*

[32] Entertainment Software Association, Essential facts about the computer and video game industry

[33] Gros, Begoña; The impact of digital games in education

One more final thing, it so important to admit that, in most cases, developing the mental skills while playing games does not lie in the game itself, but rather in the overall experience of the game. In other words, for example winning while playing the SimCity game does not mean the player may plan and moderate a real world city. It means he/she has a good ability of thinking and cooperating with other decision makers to moderate a multi-discipline task. This is because the game itself does not develop the city planning experience. It develops the cooperation and decision making skills.

5-2-2-Developing hard skills via gaming:

Once again we will use the *Crawford's* taxonomy of games. This time it is "Skill-and-Action" games where player uses his/her fast reactions and combinations of hand-controlled moves to overcome his/her virtual/human opponent. In this class of games playing repeatedly improves the eye-hand coordination skills of the player. It also improves his/her reactions speed and his/her hands ability of performing complex moves in no time. Although it is not games according to what have been explained previously but simulators are used, and still are being used, as training facilities in many cases such as training pilots, car drivers and machines operators. *Prensky* states an experiment of training navy trainees using games. He wrote[34]:

> *" Navy trainees who in a submarine simulation were being taught to look through the periscope and count the tic marks to tell the target distance found this boring, and didn't do well — until the Navy made it into a game, Bottom Gun, that let them blow anything under a certain distance out of the water. Totally unrealistic from the point of view of reality, but highly effective from the engagement and learning perspective — it got them to count those tic marks! (The Navy is still testing this, but the preliminary results show it to be true.)"*

Moreover, games are used as a training tool for new software programs. Much of the hard skills training in eLearning are IT training, and IT training is the largest segment in eLearning today[35]. For example, "*Think3"* is a company that produced computer-aided design (CAD) software for mechanical engineers. As it is new software, they encountered a lot of resistance, due in large part to the product's extremely steep learning curve because the software contained hundreds of new buttons, options and

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[34] Prensky, Marc; "Simulations": Are They Games?, in Marc Prensky (ed.), Digital Game-Based Learning, McGraw-Hill, 2001.
http://www.marcprensky.com/writing/Prensky%20-%20Simulations-Are%20They%20Games.pdf
accessed 12/02/2006

[35] Ahdell, Rolf et. al.; Games and simulations in workplace eLearning

approaches to master. For motivating others to start using the program and to ease the interaction between the user and the complex interface of the software they invented an action game to achieve that, The Monkey Wrench Conspiracy (MWC)[36].

5-2-3-Gaining knowledge via gaming:

Historically, computers have been used in education primarily as tools for supporting drill and practice for factual recall[37]. They are used as a replacement of paper-based manuals, hands on and such similar things. In these cases it is only a matter of using the games as an engaging environment rather than developing a certain skill. Many experiments showed that the knowledge gained through playing a game retains much more than that one which read or told about. For example, in their research, Grechus & Brown tested the effect of playing a PC-based game on 5th graders ability to retain nutrition information that had been taught didactically. They found that students who had played the game retained more information than a control group. [38]

Another example derives from Sweden, where the government required every adult to choose his/her own type of pension-plan. They used a game-like program to inform people about the new pension law, teach them the basics of investment, and what choices they have[39].

Generally, these games which only depend on factual recall have been popular in the educational field especially for kids. This is because they can easily be integrated into a traditional, didactic curriculum as "enrichment exercises" during independent study time. The main interest of these games is to try to increase the learner's motivation by embedding pedagogical activities in highly engaging, game-like interactions. However, several studies show that, while these educational games are usually successful in increasing student engagement, they often fail in triggering learning[40]. And this leads us to search for the characteristics of the successful educational game?

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[36] Prensky, Marc; Digital Natives, Digital Immigrants

[37] Squire, Kurt; Video Games in Education, International journal of intelligent simulations and gaming, vol.2 issue 1, pages 49-62
http://www.cyberfest.us/Video_Games_in_Education-MIT_Study.pdf accessed 01/01/2007

[38] Grechus, M. and Brown, J. Comparison of Individualized Computer Game Reinforcement Versus Peer-Interactive Board Game Reinforcement on Retention of Nutrition Label Knowledge, Journal of Health Education, vol.31 No3, 2000, pages138-42.

[39] Ahdell, Rolf et. al.; Games and simulations in workplace eLearning

[40] Conati, Cristina & Zhou, Xiaoming; Modeling Students Emotions from Cognitive Appraisal in Educational Games, in ITS 2002, 6 International Conference on Intelligent Tutoring Systems. 2002. Biarritz, France
http://citeseer.ist.psu.edu/cache/papers/cs/30243/http:zSzzSzwww.cs.ubc.cazSzzCz7EconatizSzmy-paperszSzits2002.pdf/modeling-students-emotions-from.pdf accessed 07/12/2006

6- Educational Games Characteristics:

Many researchers investigated the characteristics of the valid educational games. For example, *Thomas Walker* cites many researchers opinions about these characteristics. He points them into[41]:

- Game goals must match learning goals and they have to be clear enough that students find meaningful.
- The game should have a feedback mechanism that reviews the student's actions and decisions to enhance his/her future ones.
- The game difficulty should be changeable to be adjusted according to learner skills.
- The game sequence must not be steady; it should have random elements of surprise to ensure students engagement.
- The game should have a narrative context within which the player are involving his/her skills and gaining knowledge.
- The game should not need the player to have extraordinary previously gained skills.
- The game should neither be too hard to win, nor too easy to win all the time. In other words, the game play should be hard enough to challenge the player's abilities and skills and easy enough to prevent player from giving up.

He also admits the importance of the game type (action, adventure, puzzle…etc) according to the players preferences. He states:

> *"Amory et al suggest that students prefer 3D-adventure and strategy games to other types ("shoot-em-up", simulation, quiz/drill, etc.) These types of games possess the integration of disciplines and best incorporate problem-solving and logic skills. Those qualities seem to enhance intrinsic motivation and, therefore, learning. Students rate game elements such as logic, memory, visualization and problem-solving as the most important game elements in their perception of how effective a PC-based game is."*

One more thing that *Prensky* asserts its importance for educational games success that is after game playing debriefings. According to his point of view debriefing sessions should be held after the game playing ends. Through such sessions, usually led by an instructor or coach, players sit down and discuss what happened. This helps them to frame, highlight and

[41] Walker, Thomas B.; Computer Games As Learning Tools

generalize the various lessons and experiences they gained through playing so they can later apply them to other situations[42].

However, it is still not enough to have all these factors in an educational game to guarantee its success as an educational tool. There is still an important element that is missing which is the educator's confidence in using this game to teach his/her students. And this is why one should investigate why some teachers have doubts about this teaching methodology.

7-Gaming Doubts:

Because Gaming is a sort of a human activity, the research will predicate on the "Activity Theory" to explain the gaming contradictors doubts. Hence, at first, the theory has to be explained in brief.

7-1-The activity theory:

The activity theory states that any activity is the high level motivating concept. It is the general term that describes what the individual or group is trying to accomplish and typically indicates what outcome they are working towards[43].

The theory is an iterative model as the process of any activity involves a cyclical movement between the operations that are performed on the object of interest and assessing the outcome of those efforts. There is a constant evaluation and re-evaluation of the object against the conceptual model of the desired outcome. This feedback loop however is not limited to one individual. The theory decompounds any activity into; subject, object, tool, rules, community and division of labor and it calls the relations between these elements "Actions"(*See Figure 11*)

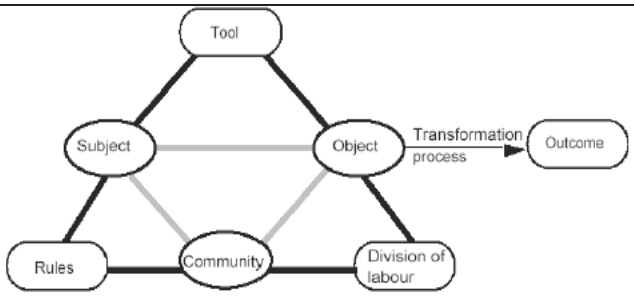

Figure 11: Engestom's classic model of Activity
Waite; Tyler, Activity Theory

[42] Prensky, Marc; "Simulations": Are They Games?

[43] Waite, Tyler; Activity Theory, Indiana University, SLIS, 2005
http://www.slis.indiana.edu/faculty/yrogers/act_theory2/ accessed 21/10/2006

7-1-1-The subject:

A subject is the individual or the group that performs the activity to achieve the activity goal.

7-1-2-The object:

It is the focus of the activity which all activity actions are meant to change to achieve the activity goal. It may be physical, such as a tool or an invention, or non-physical, such as a mental problem or a concept.

7-1-3-The actions:

The activity itself contains actions that are performed in order to accomplish specific goals that will lead the subject to achieve the desired outcome of the activity. After each action is performed the situation is assessed to determine if the goal has been achieved. The perceived difference between the current state of the object and the desired outcome provides the motivation for the individual or group to develop goals and actions to transform the object into the desired outcome.

7-1-4-The tool:

The tool is what is used to perform the action that is meant to change the object state. Like the object, it may be physical, such as a computer, or non physical, such as a theory.

7-1-5-The community:

The community is the surrounding context that the activity is performed within. The community here refers to manners, language, history, and other similar nonphysical community elements. The community not only embosoms the activity but it also constrains its actions based on its rules.

7-1-6-The rules:

Rules are constraints that describe the actions and reactions between the activity element and the role of each element.

Rules inform the individual about the object that is the focus of the activity. They inform the individual about what the desired outcome is, their place in the community and how they are to act as a member of that community. Rules also instruct the individual in how they should work on the object.

7-1-7-Division of labor:

Is the individuals whose activities help the main activity indirectly and the main activity cannot obtained without their indirect help.

And now, if using a game to teach is the "Activity", "Subject" will be both the teacher and the student, "Object" will be the narrative virtual context of the game, "Tool" will be the game software and the computer, "Rules" will be the in-game rules, "Community" will be the students community and also the institutional community, "Division of labor" could be the gaming industry and finally the "Activity goal" will be winning the game for the students and achieving the pedagogical aims for the teacher. Based on these, doubts will be explained as:

7-2-Doubts of the "Activity":

Those who are adopting using games for teaching students have many reasons support, according to there point of view, their choice. One of these reasons is considering the gaming activity as a context within which students practice and involve many skills which enhance these skills and make them better for general real life situation. On the other hand, when contradictors talks about the side effect of gaming on kids and teenagers such as violence motivation, those who defend gaming contrast these fears as the gaming violence does not encourage real life violence as it is a different matter to be violent in a game playing and be violent in real life situation[44]. Predicated on this dilemma the "Transfer Problem" evolved.

At the beginning of the 20th century, research had been conducted to investigate an idea that the mind functions as a "mental muscle" and that excellence in general subjects such as Latin or Calculus could result in increased mental functioning. *Keurt Squire* cites in his research[45]:

> *"The mind is ...a machine for making particular reactions to particular situations. It works in great detail, adapting itself to the special data of which it has had experience.... Improvements in any single mental function rarely brings about equal improvement in any other function, no matter how similar, for the working of every mental function group is conditioned by the nature of the data of each particular case".*

This means, according to this theory, involving decision-making skills while playing a game does not necessarily mean enhancing them for real life situations. This is why some have doubts about the gaming activity usefulness in general. They have very little reason to believe that players are developing skills that are useful in anything but very similar contexts.

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[44] Goldstein, Jeffrey; Effects of Electronic Games on Children

[45] Squire, Kurt; Cultural Framing of Computer/Video Games, Game Studies, an international journal of computer game research, vol.2, issue 1, July 2002
http://gamestudies.org/0102/squire/ accessed 12/07/2004

One more thing constrains using games for teaching. The Gaming activity is an activity that has to be initiated by two elements; the teacher and the student(s). For students, it is some thing so familiar to play games even if they are educational, but it is not the same for teachers. Sometimes the teacher himself becomes a very serious constraint of the activity itself because of his/her biases against the digital technology in general and games as specified digital product. In Addition, in many cases even if the teacher has not any biases against the digital technology, his/her mental structure and way of thinking are still shaped according to the conventional methodologies by which he/she was taught. *Prensky* calls these teachers as "Digital Immigrants". According to his point of view he considers them a great constraint that faces the contemporary educational process in general. He states[46]:

> *"The single biggest problem facing education today is that our Digital Immigrant instructors, who speak an outdated language (that of the pre-digital age), are struggling to teach a population that speaks an entirely new language."*

7-3-Doubts of the "Object":

The "Activity Theory" defines the "Object" as the physical or conceptual thing that all the activity actions are performed on to change its state. Predicated on this, in case of the gaming activity; the "Object" is the game narrative context. Three main issues related to the game's narrative context cause doubts about the game success in teaching. The first is the side effect of the narrative content. The second is its gender and personal attitude suitability. The final issue is the imaginary characteristics of any game.

Many education researchers are worried that the competitive nature of the gaming activity may cause a hypertension mind state, which leads to inefficient learning ability[47].

On the other hand, many games that suit boys do not suit girls and vise versa. This leads to doubts about the game success because of the gender effect of how students will interact with the game, how the personality of each student will accept or reject the narrative context of the game and for how much.[48]

Finally, the imaginary characteristics of any game may decrease its usefulness as a teaching tool. For example, the re-playability or action-reversibility of a game dilutes the seriousness of the gaming activity. In other

[46] Prensky, Marc; Digital Natives, Digital Immigrants

[47] Squire, Kurt; Cultural Framing of Computer/Video Games

[48] Mitchell, Alice et. al.; The use of computer and video games for learning

words, the student's ability to reverse or change his/her decisions as if he/she never made encourages him/her to take actions without enough serious thinking[49]. In addition, in many cases games require suspension of belief that may constrain learning or impose incorrect ideas[50]. For example, the SimCity game enlarges the mayor's abilities and authorities as if he is the only decision maker in the city and it marginalizes the other disciplines decisions and make them optional. In such a case, this imposes an incorrect idea about the city planning process although the game itself may develop many skills such as cooperation and decision making.

7-4-Doubts of the "Subject":

The "Subject" here is both the student and the teacher as both of them perform the activity. Many researchers have doubts about the students gain of the gaming activity because of the win/lose nature of the gaming activity. They fear that the binary win-lose logic of games may induce players to wield means of any kind in order to win. Thus, any seriousness implicit in the game's content may easily corrupt[51]. In addition, several studies show that, although the educational games may engage students successfully, they fail in triggering learning. Researchers indicate that this happens because many students play the games without actively reasoning about the underlying instructional domain, and thus fail to learn from the game activities[52].

7-5-Doubts of the "Tool":

The "Tool" is the game software. It is here a matter of the digital technology involved in the game rather than the game narrative context or story. Two main problems here raise the doubts of the game success in teaching; the game quality and how close it simulates reality.

For the game quality, it is a main problem that most of the produced educational games are using poor media quality. They do not represent, in most cases, the richness of other commercial games which tackle gamers imagination by high quality 3D graphics and audio. *Henry Jenkins* cites that[53]:

> *"The biggest qualm with educational software is the quality. Most look like infomercials, showing low quality, poor editing, and low production costs."*

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[49] Lee, Shuen-shing; "I Lose, Therefore I Think", A Search for Contemplation amid Wars of Push-Button Glare, The international journal of computer game research, volume 3, issue 2 December 2003 http://www.gamestudies.org/0302/lee/ accessed 29/11/2006

[50] Mitchell, Alice et. al.; The use of computer and video games for learning

[51] Lee, Shuen-shing; "I Lose, Therefore I Think"

[52] Conati, Cristina et. al.; Modeling Students Emotions from Cognitive Appraisal in Educational Games

[53] Jenkins, Henry; Game Theory

Researchers also think that the game's ability to simulate the reality is a major factor of its success as a teaching tool. Almost all games are low fidelity software; this means they simulate reality to a certain limit. Hence, the gained benefits of such games are constrained by their simulation fidelity level. And as the high fidelity games or simulators do not exist outside the governmental or military labs, games will always, at least for the near future, have a limited usefulness. Moreover games also have a so limited ability of simulating human beings. According to *Prensky*; people are the hardest to simulate of all. Human behavior never repeats, and is extremely hard to model except on the very gross level of human nature. He also explains that, predicating on *Jaron Lanier's* writings[54]:

> *"classifying people into, for example one of six (or 20, or 100) character types for purposes of simulation, as many behavioral models do, may be useful for some purposes, but may not buy you very much in terms of achieving "real world" accuracy."*

7-6-Doubts of the "Community":

The "Community" here is the institutional or scholar community. The doubts in this case are coming from the uncertainty of how these communities will accept the idea of using games to teach students. In other words, if we already have the teacher who wants to teach with games, and we get an educational game attractive enough to engage students and designed carefully to achieve the pedagogical curriculum, will we find the institutional community which helps both the "Subject" and the "Object" to perform the "Activity"? Many researchers have doubts about that, and hence they have doubts about the activity performance availability. For example *Shaffer* admits[55]:

> *"Games, perhaps for their anti-authoritarian aesthetics and inherently anti-Puritanical values, can be seen as challenging to institutional education. Even if we strip aside the blood and guts that characterize some video games, the reality is that as a form, games encourage exploration, personalized meaning-making, individual expression, and playful experimentation with social boundaries—all of which cut against-the-grain of the social mores valued in school."*

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[54] Prensky, Marc; Why NOT Simulation

[55] Shaffer, David Williamson; Squire, Kurt; Halverson, Richard; Gee, James P.; Video games and the future of learning, Wisconsin Center for Education Research, Working Paper No. 2005-4, School of Education, University of Wisconsin, Madison, June 2005
http://www.academiccolab.org/resources/gappspaper1.pdf accessed 26/12/2006

7-7-Doubts of the "Division of labor":

The "Division of Labor" is the games designers and companies that design and produce games whether they are educational or not. The problem here is that most of these companies and designers are focusing their powers towards the non educational games as they attract much more buyers. In addition, even in case of these companies which specialized in educational games, they have largely focused on early childhood. Hence, there has been no sustained exploration of how to create more sophisticated educational experiences for late adolescents[56]. This is why the idea of using games as a teaching tool is nearly limited to the early scholar years.

7-8-Doubts of the "Activity Goal":

In case of playing educational games, the "Activity Goal" is not the same for the student as it is for the teacher where both of them are the "Subject" of the activity. For the student; the goal of any gaming activity is to win the game. However, for any teacher; the aim of making a student plays an educational game is to teach him something. The dilemma here is that; what if the student's goal does not match the teacher's goal? This is what is called the "Subject" tensions as both of the students and the teacher are the subject that performs the same activity but each of them has a different goal. In some cases, achieving the student's goal does not necessarily mean that the teacher has achieved his/her own and vise versa. For example, *Squire* states that[57]:

> *"In a situation where Civilization III is used in formal learning environments, one might imagine tensions between winning Civilization III and learning social studies as the object of an activity system, depending on whether the student or the teacher is the subject of the activity system"*

Think of playing SimCity game as another example. A player may find his/her own tactic that makes him moderate a well-established city and he/she may plan his/her own one as linear planning. He/She will always adopt this planning typology to win the game as he/she examined it before and knows about its problems and how he/she can overcome and deal with them. On the other hand, the teacher will never aim at making his/her student master the linear planning typology. His/her goal is to make the student aware of the different city planning typologies to compare advantages and disadvantages. If he/she makes the student choose another city planning typology rather than the one he/she is familiar with, the student may lose which means the student does not achieve his/her own goal. This is why if the

[56] Jenkins, Henry; Game Theory

[57] Squire, Kurt; Cultural Framing of Computer/Video Games

activity goal is not chosen and designed carefully, it may cause a conflict that leads to an activity failure.

Yet, despite all the previously mentioned contradictions and doubts, and because of the benefits of using games that also have been mentioned before, many are struggling and trying to use games as teaching and training tools. This is what will be explained under the next section.

8-Examples of Using Digital Games for Teaching and Training:

This part of the research does not aim at pointing out an exclusive list of games that are used in teaching and training. It aims at giving examples of how much games are used seriously for teaching and training adults, rather than kids, on serious matters.

8-1-Sweden's Pension Law

In Sweden, the government required every adult to choose his or her own type of pension-plan. This has resulted in a great need for materials to inform people about the new pension law, teaching the basics of investment, and what choices they have. Productions have been made for organizations on this topic. Leading edge companies are using these simulation games outside their own organization, educating both suppliers and customers along the value-chain[58].

8-2-C-VIBE

It is an advanced learning system taking advantage of simulation, multimedia, virtual reality, agents/avatars-based, and multi-user, distributed communication technologies to deliver a realistic learning experience addressing the dynamics of change and innovation processes in organizations. It is based on an existing 2D standalone change management simulation game, the “EIS simulation”, which is now used extensively in top business schools and universities (MIT, Wharton, Stanford, etc.) and companies. The team of learners operates like a group of ‘change agents sent in a (virtual) company, in which they can spend up to 6 simulated months and interact with/try to convince a number of (virtual) managers modeled with very realistic profiles, behavior and different ways of resisting the innovation[59].

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[58] Ahdell, Rolf et. al.; Games and simulations in workplace eLearning

[59] Nabeth, Thierry & Angehrn, Albert A.; Embedding 2D Standalone Educational Simulation Games in 3D Multi-Users Environments: The Case of C-VIBE, in Proceedings of the IEEE International Conference on Advanced Learning Technologies (ICALT 2004), Joensuu, Finland, pages 711-713 http://www.calt.insead.edu/Publication/conference/2004-icalt-Embedding_2D_Standalone_Educational_Simulation_Games_in_3D_Multi-Users_Environments-The_Case_of_C-VIBE.pdf accessed 20/11/2006

8-3-Simulations of International Politics

A variety of political science courses at the University of Melbourne, including Middle East politics, World Politics, Theories of Power, Russian Politics, Australian Foreign Policy, and International Politics of the Asia-Pacific were originally lecture based with essays and tutorial participation as their mode of delivery. The stated pedagogical objectives of all these courses included understanding the political processes and dilemmas faced by leaders in these regions and the theories and explanations that may be useful to understand these processes. Recently, for all these courses, students were given the choice between participation in a simulation involving working on roles as teams or individually doing another essay or exam. Significantly in all these courses the majority usually chooses to do the simulation despite the fact that they were warned and knew from former students of the course that it involved more work than the other alternatives[60].

8-4-Australian History

Professor Sandra Wills from the University of Wollongong has developed a database of the convicts who arrived on the First Fleet to Australia in 1788 and has added a role-play simulation as an active learning methodology for students to develop a better understanding of the lives of those involved in the early days of white Australian settlement. In the simulation, participants do not research their roles but are given a description of their character, which is based on known historical fact found in the database. The pedagogical objective is to bring to life the records of a database so that students better understand the historical conditions of early white settlement in Australia rather than current affairs and concerns. The social context for learning is developed out of the contents of the database and the interactions between roles within and across 'camps constitute the collaborative arena for finding a solution. In the process students acquire, knowledge of the facts, an understanding of the difficulties and skills for researching this database[61].

8-5-Bottom Gun

While performing their roles as navy soldiers into a submarine simulator, navy trainees were being taught to look through the periscope and count the tic marks to tell the target distance. Observers found that trainees felt bored while doing this job which makes them not fully engaged in the training. This is why they made it into a game, Bottom Gun, which let them

[60] Linser, Roni et. al.; Beyond the Current E-Learning paradigm

[61] Ibid.

blow anything under a certain distance out of the water. Although the matter is totally unrealistic, but highly effective from the engagement and learning perspective which motivates the trainees to count those tic marks[62].

8-6-CLUES

The Community Land Use and Economics Simulation (CLUES) was developed to model the complex interaction between social, environmental, political and economic forces at the community level. It was field tested with community leaders and other academics from the northeast U.S. in 1991-1994 and further adapted for use with college and (4-H) student audiences[63]. The CLUES simulation was first tested in a non-U.S. context in March 1995 with a group of central and eastern European graduate students at the University of Agriculture in Nitra, Slovakia. It was translated into Slovak and used with sophomores at the university in February, 1996.[64]

8-7-Monkey Wrench Conspiracy

A group of professors developed new computer-aided design (CAD) software for mechanical engineers but the new software encountered a lot of resistance, due in large part to the product extremely steep learning curve as it contains hundreds of new buttons, options and approaches to master.

Their marketers observed that the users of CAD software were almost exclusively male engineers between 20 and 30; hence they invented and created a computer game in the “first person shooter” style of the consumer games Doom and Quake, called The Monkey Wrench Conspiracy. The player's goal is to overcome his/her virtual enemy by building tools, fixing weapons, and defeating booby traps which all may be done by using the new CAD software. The game has been phenomenally successful in getting young people interested in learning the software. It is widely used by engineering students around the world, with over 1 million copies of the game in print[65].

8-8-Environmental Detectives (ED)

The MIT Teacher Education Program, in conjunction with The Education Arcade, has been working on creating "Augmented Reality" simulations to engage people in simulation games that combine real world

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[62] Prensky, Marc; “Simulations”: Are They Games?

[63] (4-H in the United States is a youth organization with the mission of "engaging youth to reach their fullest potential while advancing the field of youth development." The four "H"'s stand for Head, Heart, Hands, and Health.) Wikipedia, http://en.wikipedia.org/wiki/4-H accessed 20/08/07

[64] Warner, Mildred & Belajova, Anna; Using Community Development Simulations in Divergent International Contexts, Journal of Extension, August 1996, Volume 34, Number 4.
http://www.joe.org/joe/1996august/iw2.html accessed 05/01/2007

[65] Prensky, Marc; Digital Natives, Digital Immigrants

experiences with additional information supplied to them by handheld computers. One of these games is the Environmental Detective.

The game is an outdoor game in which players using GPS guided handheld computers try to uncover the source of a toxic spill by interviewing virtual characters and conducting large scale simulated environmental measurements and analyzing data. This game has been run at three sites, including MIT, a nearby nature center, and a local high school. Early research has shown that this mode of learning is successful in engaging university and secondary school students in large scale environmental engineering studies, and providing an authentic mode of scientific investigation[66].

8-9-MIT Ghost

Each year, new students from all over the world arrive on campus with a limited sense of the MIT lifestyle and experience until they suddenly find themselves in the thick of it. MIT Ghost is a game that is developed to make roommates could get to know each other online before they arrived on campus and to provide students with a more immediate experience of what the departments and lab cultures are like. The game takes the idea of an open university to the next level, creating a customizable, persistent online representation of MIT and its various cultural communities that will operate much like massively multiplayer role playing games. The project is a trial to make MIT cultures more widely accessible[67].

8-10-Revolution

Revolution is an American Revolution-themed role-playing game based on historical events in the town of colonial Williamsburg. The game gives students an opportunity to experience the daily social, economic, and political lives of the town inhabitants. By allowing role-play from one of seven social perspectives, Revolution places students in a situated learning context. The game teaches students an ordinary experience of history that includes passionate rhetoric and heroic battle, but also economic frustration, political indifference, and the mundane of everyday life[68].

8-11-DreamHaus

DreamHaus is an adventure/ puzzle game designed for 18 years old students and over studying advanced placement (AP) and introductory college physics and engineering. The game uses architecture as an entry point for learning AP-level mathematics, engineering, and physics material. In

[66] The Education Arcade, http://www.educationarcade.org/aurg accessed 17/02/2007
[67] The Education Arcade, http://www.educationarcade.org/ghost accessed 29/11/2006
[68] The Education Arcade, http://www.educationarcade.org/revolution accessed 29/11/2006

DreamHaus, players examine virtual architectural sites (such as the Tokyo Olympic Stadium), solve physics and engineering-based puzzles, and complete architectural design challenges using the game design tools. Players may also participate in a web-based community surrounding the game, submitting their designs, viewing others work, or offering critique on designs[69].

9-Chapter Four Summary:

As a conclusion of the educational games investigation, one may point out:

1. Using games as educational tools is not a fictitious issue because we find it naturally within natural life.
2. The digital era we live within nowadays, characterizes the new generations with new skills and abilities that no longer match with the conventional teaching/learning methods.
3. Many statistics and research have found that, games are the most spread and familiar digital product that new generations deal with.
4. Games have two important matters that may cause them to be a powerful educational tool in the near future. The first is its ability to be an engaging environment. The second is its ability to be a safe and cheap environment for skills practicing and developing.
5. Games have the ability to develop the player's soft skills as much as his/her hard skills according to the game narrative contexts and aim. Moreover, games have the ability to be used as a vehicle of knowledge acquisition
6. Despite their wonderful abilities, games still have contradictors who have many doubts about their usefulness and seriousness.
7. Many organizations and academic institutions are still struggling and trying to overcome the contradictors doubts and are using many educational games for teaching and training adults on so serious subjects.

Now, Predicated on the previous investigation of the educational games and the previously mentioned assumptions and needs which have been discussed through chapters One, Two and Three, it is obvious that using

[69] Hauck, Robin; Miller, Heather; Nataf, Zachary; Squire, Kurt; Jenkins, Henry; DREAMHAUS, Design Document, MIT GAMES-TO-TEACH PROJECT
http://www.educationarcade.org/gtt/documents/dreamhaus/dreamhaus.doc accessed 28/07/2004

games as educational tools for teaching architecture could be a valid choice. The next chapter will try to deduct the theoretical ability of games, especially the non-educational ones, that are On-The-Shelf nowadays to fulfill the educational needs of the "What", "How" and "Why" trilogy of the architectural education.

5- Chapter Five: Games and the *"What, How and Why*" Trilogy.

"Educational software is typically disliked by students 'because the fun factor is missing. Educational games are preferred to standard classroom instruction, but – and this is a big but – students…would never voluntarily play such a game outside of class. Crucially, learning games need to be perceived to be as good as commercial games. To sustain engagement, fun, speed and ease of use are keys, as is variety: in context, mission and complexity"[1]

[1] Mitchell, Alice et. al.

1- Introduction:

This chapter will try to investigate, through an analytical study, the abilities of chosen commercial games to fulfill the needs of the architectural education trilogy "What", "How" and "Why", which has been investigated previously. Before that, the "What", "How" and "Why" trilogy need to be more explained briefly.

Predicated on *Sherry's* citation; knowledge may be structured into three main structures: conceptual, procedural, and theoretical. A conceptual knowledge structure shows us what something is, a procedural knowledge structure shows us how something works, and a theoretical knowledge structure shows us why something works.[2]

For example, when we ask a student to design a private house, we need to teach him the three structures of knowledge. Classified under the "What" issues, there will be all that is related to data and facts. The student is supposed to **know** the general components of a private house. He/She is supposed to know about bedrooms, living rooms, bathrooms, kitchens, the furniture of each space and their dimensions and other related facts and data. Then the student is asked to **do** connections and relations between spaces according to a relationship matrix and a zoning diagram and these issues which are classified under the "How" subjects. Finally the student may do all these entire tasks in a right way but the product may still be inconvenient for the society where it will be built in. This is when we need him to **appreciate** "Why" some societies adopt certain architecture, and why what is valid for a society may be invalid for another.

This is the "What", "How" and "Why" trilogy and its associated action verbs; "To Know" "To Do" and "To Appreciate".

2-The "What" Subjects:

"Knowing What" subjects are those related to data, facts, and theories. Their main aim is to increase the student's cognition state as they are about knowledge, facts and data acquisition. For example in case of architecture education, we talk about subjects such as architectural language, presentation and rendering methods, drafting tools and techniques, color theories, building materials, construction systems and methods, architectural styles, modern technologies in architecture, environmental control elements and theories, architectural styles principals, and other similar subjects.

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[2] Sherry, L., & Trigg, M. (1996). Epistemic forms and epistemic games. Educational Technology, 36(3), 38-44.
http://carbon.cudenver.edu/~lsherry/pubs/e_games.html accessed 27/12/2006

In general, games have been used so widely as learning tools in case of "Knowing What" subjects as they are used with the drill and practice techniques. There are many educational games that are designed based on an embedded educational curriculum. They have an acceptable success especially in case of teaching kids. The main problem with such games is the poor graphics and multimedia technology that is used to produce them. This poverty causes a limited engagement effect of these games especially when they are compared with other commercial games.

2-1-The "What" Subjects needs:

In such educational games, there is always a need to specify components to achieve the pedagogical goal of the game. These components are; the knowledge base component, the questioning/testing scenario, the evaluation mechanism and finally, in some cases, a coaching/helping avatar.

2-1-1-Knowledge base component

This is where the data, knowledge facts and theories are stored. It plays two major roles. The first role is a browseable database that the student navigates through to search for information. The second role is being the benchmark that the student's answers are compared with.

2-1-2-Questioning/testing scenario

In such games, the game implies many questions the student has to answer to continue the game. In the poorest designed games, the implying scenario of these questions are very primitive as they are not a part of the game narrative context itself, they are only obstacles that prevent the player from continuing to play. In other words, if these questions are omitted, the playing scenario and the game narrative context will not be affected. Moreover, in most of these cases the questions are generated randomly from a questions bank which is associated with the knowledge base component.

On the other hand, if it is a well-designed game, these questions are implied into the narrative context of the game and they come according to a pre-designed plan that makes them vital to understand the playing scenario to achieve the game goal perfectly.

2-1-3-Evaluation mechanism

The evaluation mechanism is responsible for evaluating the player's answers and scoring them.

2-1-4-Coaching/helping avatar

The role of the coaching/helping mechanism is to guide the player through the playing session. It does not always have a role in the pedagogical content as it does not offer hints or solutions in the questioning phase. In these cases its role is to explain the game interface and how to play the game. In other games it coaches the player academically as it provides hints while playing the game.

In the coming section, two games will be investigated. One of these games; The Magic School Bus, is educational. The other; Danger By Design, is not an educational game, it is an adventure commercial game. The research will try to explain the previously mentioned educational games components in the first game and see how they can be found in the other adventure game.

2-2-"The Magic School Bus"

Based on Scholastic's award-winning book series, this game is designed to entertain and encourage a sense of adventure and exploration, especially about science and technology. The Magic School Bus Explores the Solar System. The player controls the bus and explores the nine planets in the solar system, conducting science experiments and playing games at each stop[3]. The game is classified as an educational game that is developed for kids. *See Figure 12*

2-2-1-The In-Game Knowledge Base:

The in-game knowledge base is available to the player as a narrated material whenever he/she chooses to know more about the solar system or any of its components. *See Figure 13*

2-2-2-Questioning/testing scenario

The game provides the testing scenario as a seeking trip on the outer space to find the virtual teacher. She, before vanishing, gave scientific clues about where she is and it is the students duty to find her. While seeking the solar system, students find more scientific information and games on each planet. *See Figure 14*

2-2-3-Evaluation mechanism

The game does not use points score as an evaluation mechanism. It depends on finding the teacher as a winning state. This means that there is no competition value between a player and another as there is no performance meter to determine which player performs better than the other.

[3] http://www.scholastic.com/magicschoolbus/cdrom/ex_solar_system.htm

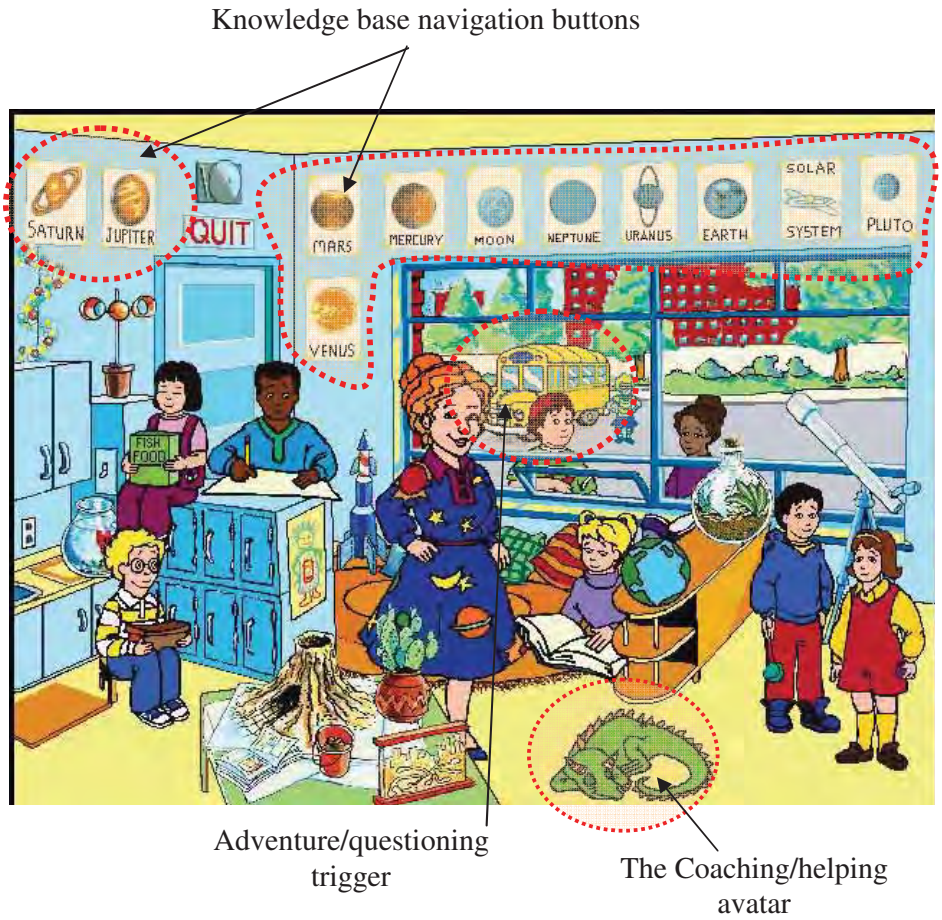

Figure 12: "The Magic School Bus"; The starting interface of the game

2-2-4-Coaching/helping avatar

The coaching avatar role in the game is only to explain the different interfaces of the games. It does not provide any scientific help through the game. *See Figure 12*

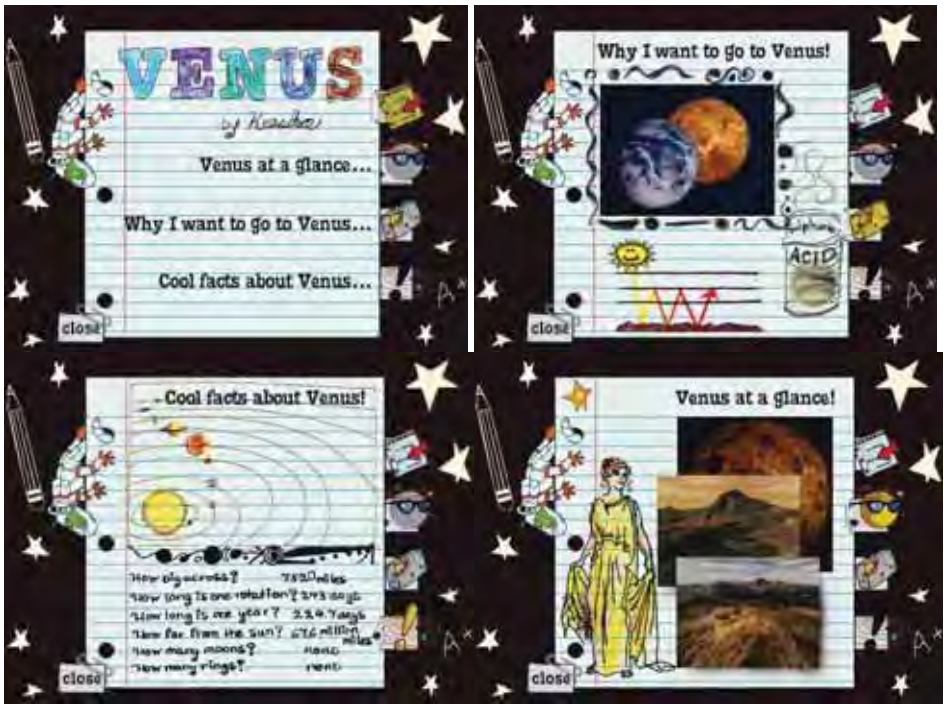

Figure 13: "The Magic School Bus"; Screen shots of the narrated knowledge base of the planet Venus

Figure 14: "The Magic School Bus"; One of the "On Planet" scientific games where player has the ability to cut each planet to explore its inner components.

2-3-"Danger by Design"

Developer: Her Interactive, http://www.herinteractive.com/corp/
Publisher: DreamCatcher, http://www.dreamcatchergames.com/
Release date: July 24, 2006
Genre: Adventure
Mode: Single player
Rating: ESRB Everyone (E)
Platform: PC

"Danger by Design" is the fourteenth installment in the Nancy Drew computer game series. The game puts the player in the shoes of the detective Nancy Drew, where he/she sees everything from her point of view. The game is an adventure game and full of riddles and mind-challenging missions.

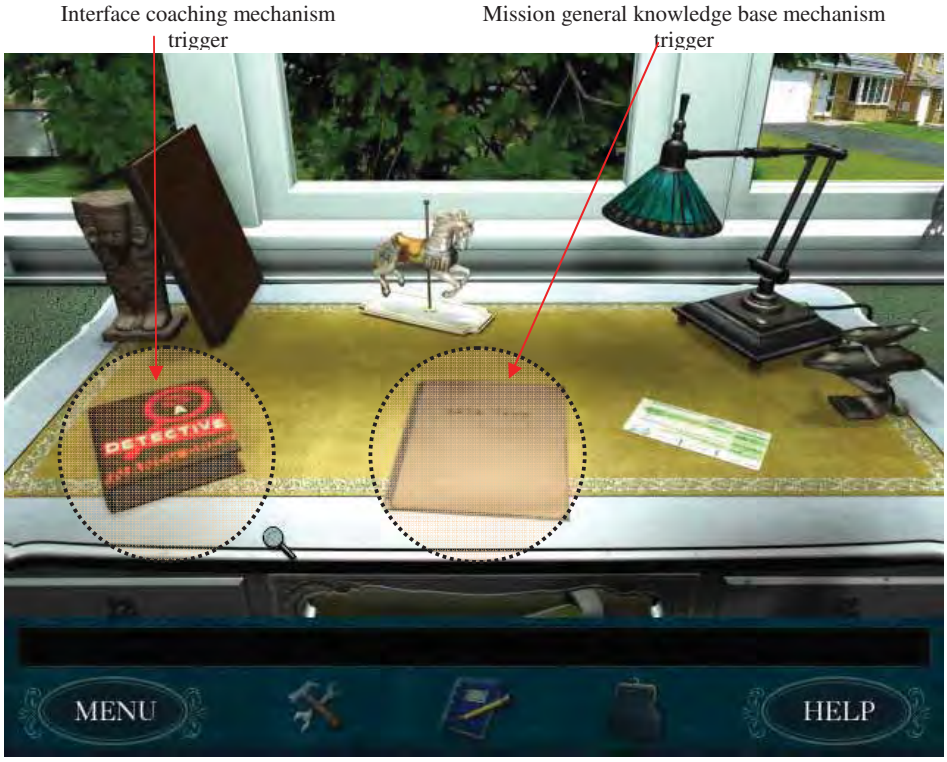

Figure 15: "Danger by Design"; Starting interface

2-3-1-The In-Game Knowledge Base:

Generally, in such adventure games the knowledge base is not exactly a knowledge base. The matter in such games is a pre-mission description

which leads to the riddle solution. For example, one of the missions that face the player in the "Danger by Design" game is to prepare a potion to the boss character. This potion must be prepared according to many things, which the player should notice himself; else, he/she will make it in a wrong way. Failing to prepare the right potion means to make the boss angry and thus to be fired which is "losing" the game. *See Figure 15, Figure 16 & Figure 17*

2-3-2-Questioning/testing scenario

In such games, riddles and unsolved problems and key locks are the general testing mechanism. These riddles are implied as a part of the game scenario thus the player never feels they are imposed on the game scenario. Solving these riddles enables the player to step forward towards his/her aim; to win the challenge. *See Figure 17*

2-3-3-Evaluation mechanism

In this game success comes as a result of solving a riddle after another which leads at the end to the winning state. Again, there is no competition between different players as there is no meter for their performance while struggling towards the final goal. The only challenge here is between the player and the game designer as he who assigned the riddles.

Figure 16: "Danger By Design"; Mission general knowledge base mechanism

2-3-4-Coaching/helping avatar

In most cases of such games, the coaching/helping mechanism is not assigned to just one avatar. There are many characters or mechanisms that may help the player while playing the game. Each one of them is implied in a specified part of the game story that matches the story line. *See Figure 18*

Figure 17: "Danger By Design"; The riddle, "preparing a potion", and its knowledge base

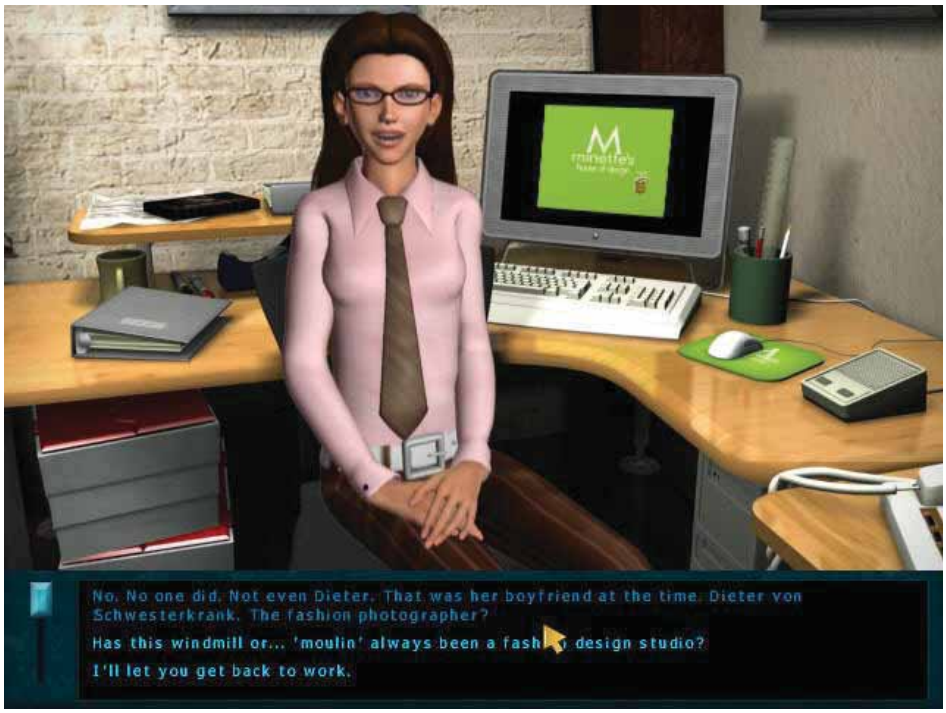

Figure 18: "Danger By Design"; One of the helping avatars of the game

2-4-The "What" subject summary:

The "What" subjects aim at facts and knowledge acquisition. Thus, the educational games designed to help teaching such subjects provide the player with a knowledge base and then question him about its content. These games use different mechanisms for evaluating the player's answers but they all record the player's winning state achievement. In addition, a coaching/helping mechanism is provided to help the player either scientifically or by explaining how to play or both of them.

Adventure games in general depend on data seeking and solving riddles; hence this games class may be used, with some modifications, to teach "What" subjects. For example, think of architectural problems such as isolating a basement to prevent the ground water or spanning a long distance with short wooden beams. It is possible to imply such problems within a narrative scenario and then reform it to be an adventure game where the winning state is achieved by solving these riddles/problems.

3-The "How" Subjects:

"Knowing How" subjects are all those relating to general processes of operating or performing an issue. Team management, cooperation with other

disciplines, defining a problem and finding its needs, and others, are sorts of "How" subjects. In these cases the aim is not to gain knowledge or facts. The aim here is to train the student to perform a task or a process. The main problem in such subjects is their need to be practiced. Practicing here is an essential teaching need as it gives the student the opportunity to test his/her ideas, analyze his/her decisions and find out how they affect the process validity. In this case, practice helps the student to construct his/her own experience that is based on his/her actions and remarks. This is much better than to be told about how the process is performed. Moreover, predicated on the cone of learning of *Edgar Dale (Figure 3)*, the active teaching methods, where practicing is one of them, cause much more knowledge-retaining ability. Hence, to search for a game that may help practicing the "How" issues, one first has to point out what is needed of the practicing context of the "How" issues.

3-1-"How" Subjects Needs

To perform a process virtually, one should first have a virtual context which is similar to the real context within which the process is performed. The virtual context has to be abstracted of unnecessary elements and factors which do not affect the context validity for performing the process. The virtual context here is not only a narrative context that envelops the process but it also shapes the availabilities and limitations of the process. In addition, the virtual context should provide action tools which give the player the ability to execute his/her decisions. In addition, it is a must to find out what are the outcomes of these actions, this is why the virtual context must be accompanied by a feedback mechanism to express the player's actions outputs. After that, player needs to evaluate his/her actions according to his/her observations of their effects. It is also useful to have others feedback and comments as this enriches the player's future decisions. Finally, the player will need an evaluation to know how his/her total performance is.

Hence, the chosen game, SimCity 4, will be investigated based on these points:

- The Game Fidelity.
- Decisions/Actions Tools.
- Analysis Mechanisms.
- Player's Performance Coaching.
- Player's Performance Evaluation.

3-2-SimCity 4

Developer:	Maxis, http://www.maxis.com/
Publisher:	Electronic Arts, http://www.ea.com/
Release date:	January 10, 2003
Genre:	Simulation
Mode:	Single player
Rating:	ESRB: E
Platform:	PC

SimCity 4[4] is the newest version of an urban management game released by Maxis Co. It may be considered, as a digital version of the traditional game CLUG (Community Land Use Game) which had been designed in the 1960s by Professor *Allan Feldt* of the department of City and Regional Planning at Cornell University[5]. The game is about building and moderating a new, or already established, community through playing the role of the City Mayor. The game is classified as a strategy, simulation game. *See Figure 19*

3-2-1-The Game Fidelity

The game involves a highly 3D graphical representation of the city and the player's actions as a tool for engaging who plays. Moreover, the game provides some ready made famous cities such as Tokyo and Paris to be played with. In addition, the game tries to simulate the reality by representing the time factor. It consumes some simulated time to develop the city and also to represent the mayor/player actions effects. Because of the city development, city inhabitants start to ask for their needs such as increasing housing lots, commercial markets or industrial zones. The game makes a dependent relation between industry zones, which means job opportunities, and asking for residential plots. It also makes a relation between the type of industry and the educational level of inhabitants. One of the game weak points is its focusing on the mayor's authorities and making him the only decision maker of every thing related to moderating and planning the city, which contrasts the real situation. In addition, there is no evidence that the game is based on valid planning equations. Hence, one cannot expect to gain academic facts and data by the game playing, at least until now.

[4] MAXIS™, http://www.simcity4.com/

[5] Zuber, Eileen, (1997): Community Land Use and Economic Simulation (CLUES) http://www.cas.nercrd.psu.edu accessed 12/8/2004

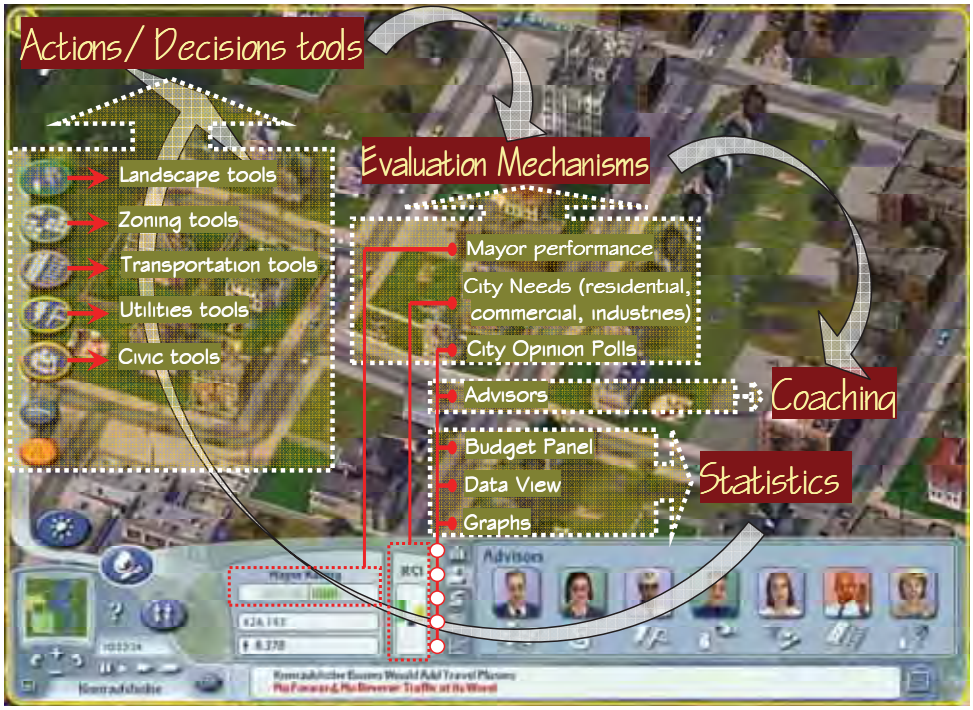

Figure 19: SimCity; An analytical representation of the game interface

In general, if it is a matter of city planning, the game is similar to the real process for a certain limit. However, if it is a matter of logical thinking while planning a city, the game virtual context is so suitable and represents what is needed to perform the process.

3-2-2-Decisions/Actions Tools

The game gives the player a limited budget, in the beginning of his/her career, to start planning and acting within this limit. He, the mayor, has to put a financial plan within which he can match between income and expenses. As a start the mayor has to zone his city, if it is a new one, and plan where will be the residential, commercial and also industrial zones. He also plans where and what utilities will be raised in the city, this includes utilities and services like: schools, colleges, clinics, hospital, police stations, fire stations…etc.

Figure 20: SimCity; one of the graphs that represent history of city development

3-2-3-Analysis Mechanisms

The game provides a set of statistics that give the player the ability to analyze his/her performance. There are graphs representing the history of the city development *Figure 20*. It also provides an agenda that controls income, through taxes and financial deals, and expenses like salaries, maintenance costs, public services expenses and others. *See Figure 21*

3-2-4-Player's Performance Coaching

The game provides to the player a group of advisors that always alert him in case of finding problems. They give hints about the problem causes and how it may be solved. They play no role more than advising the mayor and they do not force him to do any specific actions, in most cases such pieces of advice are well matured and valuable. *See Figure 22 & Figure 23*

Figure 21: SimCity; Income / expenses agenda of the city

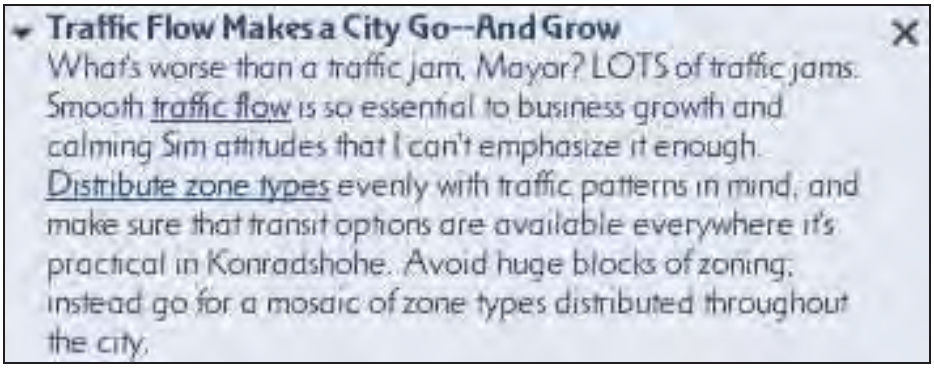

Figure 22: SimCity; Traffic Advisor offers the City Mayor an advise about a traffic problem and suggests a solving methodology

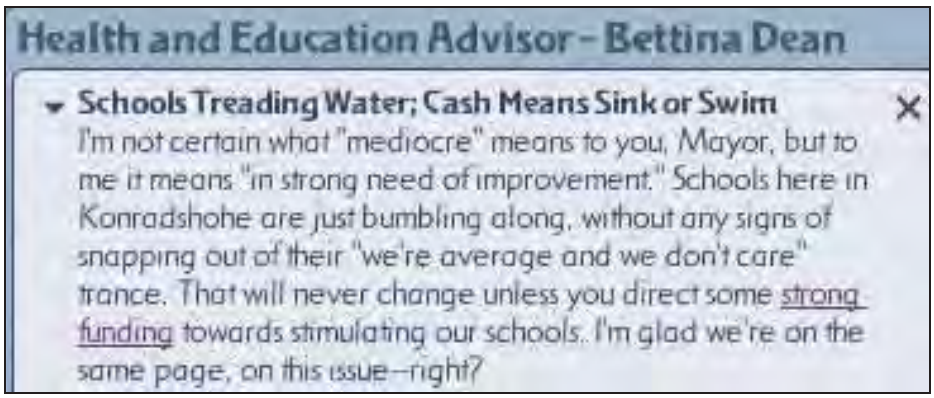

Figure 23: SimCity; Education Advisor states an educational problem and suggests a methodology to solve it.

3-2-5-Player's Performance Evaluation

Finally, by keeping an eye on "City Opinion Polls" and "Mayor Rating", the player can always know how his/her city inhabitants evaluate his/her performance and know his/her elector opinions. *See Figure 24*

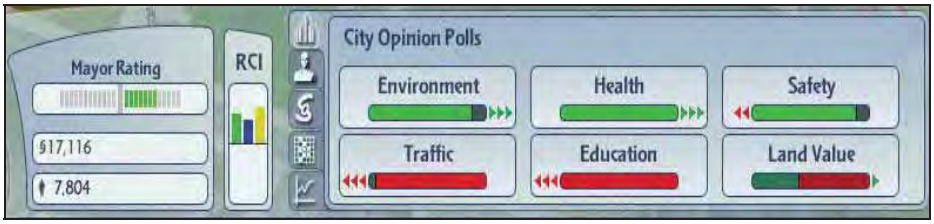

Figure 24: SimCity; Evaluation Mechanisms of the City Mayor

3-2-6-The "How" subject summary

As it is clear, in the game, player performance is typical to *Kolb's* cycle of learning. He/She investigates city needs then he/she makes decision and actions. After actions results take place, he/she starts to evaluate his/her decisions outcomes and the city inhabitants reactions. According to this, he/she starts to do other actions and modifications aiming to satisfy his/her city inhabitants and investors and still fulfill his/her strategies and plans. Through this cycle of **action→ review → planning → action**, the player practices a mental skill of how to take urban planning decisions.

4-The "Why" Subjects:

"Knowing Why" subjects are those related to appreciation. Therefore, it is not only a matter of knowledge but it is also a matter of self-inclination and beliefes that need to be built up through a long period of self-gained experiences. If educators try to depend on the "Experiential Learning" methodology to teach students "Knowing Why" issues, they, the educators, need to put students into real life situations and let students take decisions and see what these decisions lead to.

For example, if instructors need to make students appreciate, not only know, the need for a certain type of architecture for a rural community; they either "Tell" them why this society adopts this architecture, or they have them make design decisions and ask them to observe and analyze how community/individuals will react to these decisions. After that, students start to modify their previously made design decisions based on their observations and analysis and re-observe their modification effects until they themselves find out why the community adopts this architecture. This is how the learning cycle goes according to the "Experiential Learning" cycle. The problem here is who will be the client representing his/her society, for how long he/she is going to be available, and how much he/she is ready for accepting students errors? In other words, there is a need for a "Virtual" client who represents his/her society as much as possible.

4-1-"Why" Subjects Needs

Because they are general needs of any experiential learning mechanism, the "Why" subjects also require all the needs that have been addressed earlier while discussing the "How" subjects needs. But in addition to these, there is still a need to a virtual client who fulfills what have been mentioned previously. Hence, this virtual client should have certain characteristics which are:

- **Representative of different communities/societies:** The virtual client should not stick to a certain community forever. He/She has to represent a different community/society every time according to the instructor's goals. This insures the instructor's ability to differentiate the self- gained experiences the students get every time.
- **Honest representative of his/her society:** The virtual client should bear, as much as possible, all the main characteristics, behaviorally and visually, that indicate his/her society.
- **Expressive:** He/she has to have a good ability to express his/her needs
- **Interactive:** The virtual client has to deal interactively with any design decisions which the player makes. Moreover, the virtual client should

deal interactively with the player to guarantee the personal interaction between player and the game which leads to engagement.

- **Criticizing:** He/she should have the ability of showing what he/she dislikes, in the design, and to represent his/her happiness for good design decisions. This is to offer a sort of challenge in the game to guarantee student's attraction and ego gratification in the winning state.

Predicated on these characteristics, the chosen game, Sims II, will be investigated. This game mainly depends on a virtual character that represents the player. This character deals with other characters to build up a human family life within a community. The game is not categorized as an educational game but it is classified as a simulation game for entertainment[6]. Two main reasons are behind choosing this game to be an example of the digital games abilities:

- Its scenario is about a family life within a community.
- It may be considered as a good representative of what simulation games are capable of.

4-2-Sims II

Developer:	Maxis, http://www.maxis.com/
Publisher:	Electronic Arts, http://www.ea.com/
Release date:	September 14, 2004
Genre:	Life simulation game
Mode:	Single player
Rating:	ESRB: E10+
Platform:	PC

Sims II[7] is the newest version of a community building game released by Maxis Co. The game is about moderating a male/female life within a neighborhood community. The player has the responsibility of satisfying the physical and psychological human needs of the character he/she controls. The player also plans the character's career and how his/her character can progress to achieve the maximum success.

4-2-1-Changeability:

The game offers the players two levels of changeability; the ability of choosing and changing the community *Figure 25*, and the character to control. For the community, the player has the ability to make changes in the physical environment of the neighborhood. He/she can design the lots distribution, the neighborhood landscape and add new families to live in the neighborhood

[6] Wikipedia, the free encyclopedia http://en.wikipedia.org/wiki/The_Sims_2 accessed 26/6/2006

[7] MAXIS™, http://www.thesims2.ea.com

Figure 26. On the other hand, the player has the ability to design his/her own character he/she will control or to choose a ready-made one *Figure 27*. The player may change the visual appearance, the behavioral and psychological characteristics of his/her character.

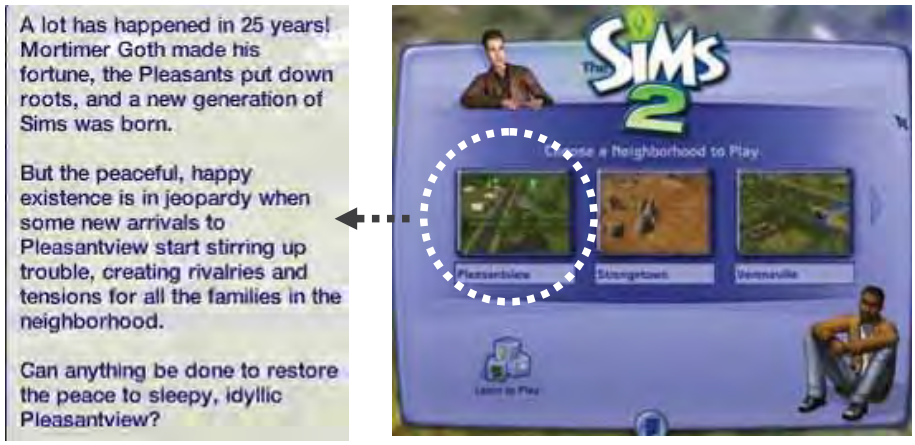

Figure 25: SimII; the game starting interface

4-2-2-Honest representative of society:

One of the most important advantages of the game is that the player may use "Patches" or "Plug Ins" to have certain, pre-made, characters and/or neighborhoods. This means the ability to have certain characters or neighborhoods with special characteristics to be plugged into the game and play with.

4-2-3-Expressive

When the player plays with his/her representative character, he/she has many windows that tell him about his/her character's needs whether they are physical or psychological. *See Figure 28*

Figure 26: Sims II; Editing interface of the physical environment of the neighborhood

4-2-4-Interactivity

The player at first has the ability of either to do his/her own design decisions or to deal with a ready-made design. He/she also has the ability of making modifications to his/her design any time he/she needs to *Figure 29 & Figure 30*. Moreover, the player interacts with his/her representative character and guides it through a set of menus that differ according to many factors such as; the character mood, the time, the relation between the character and its peers …etc. *See Figure 31*

4-2-5-Criticizing

The character has the ability of showing its happiness and anger through two ways. One of them is the mood meter that changes its color according to how much the character is happy or feeling sad. The other is a pop up cloud that comes out of the character to show what it thinks of or talks about. *See Figure 32*

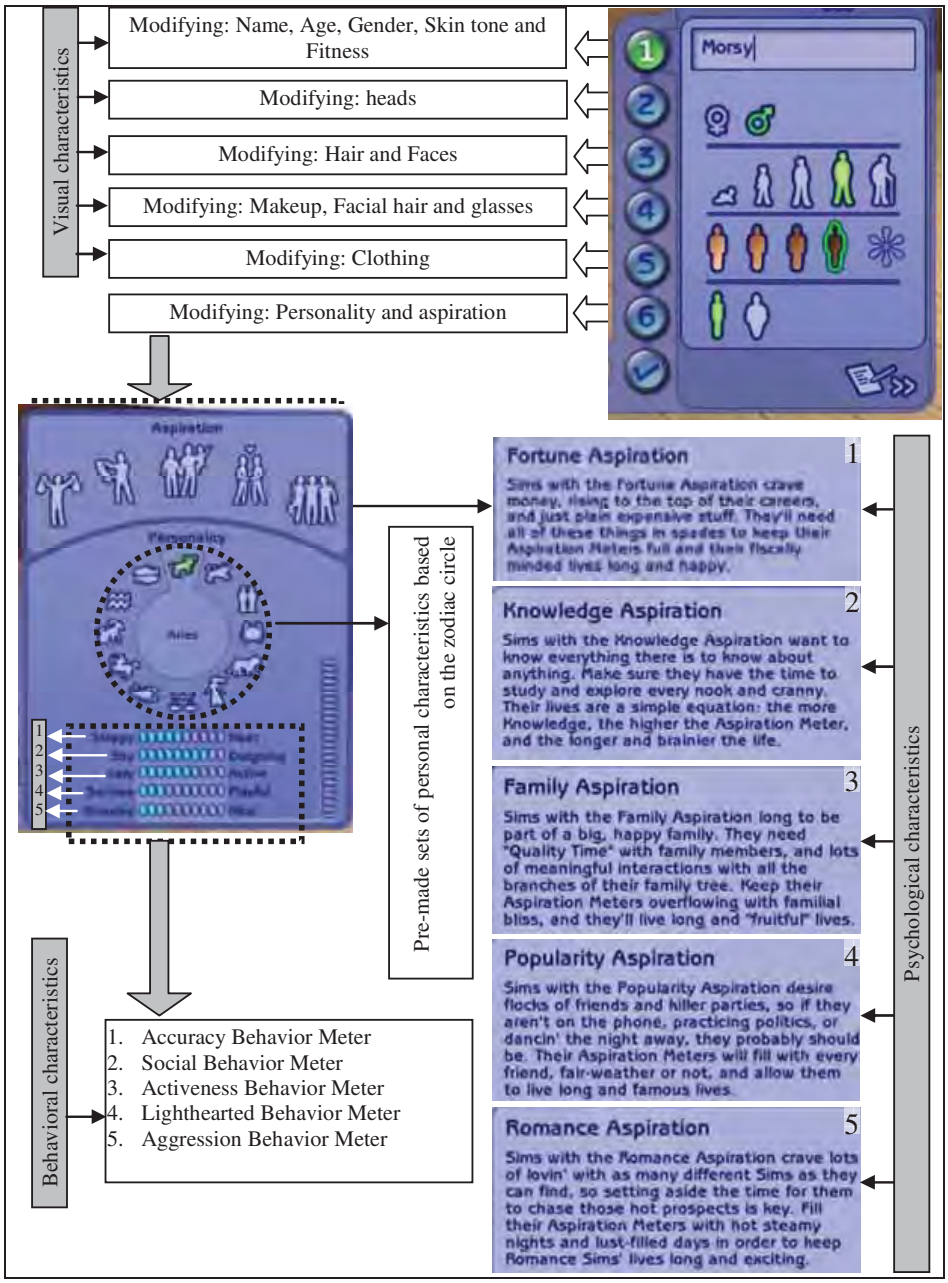

Figure 27: Sims II; The controllers of the character's visual, behavioral and psychological characteristics.

Figure 28: Sims II; The character's meters that express the needs, mood, dreams and fears.

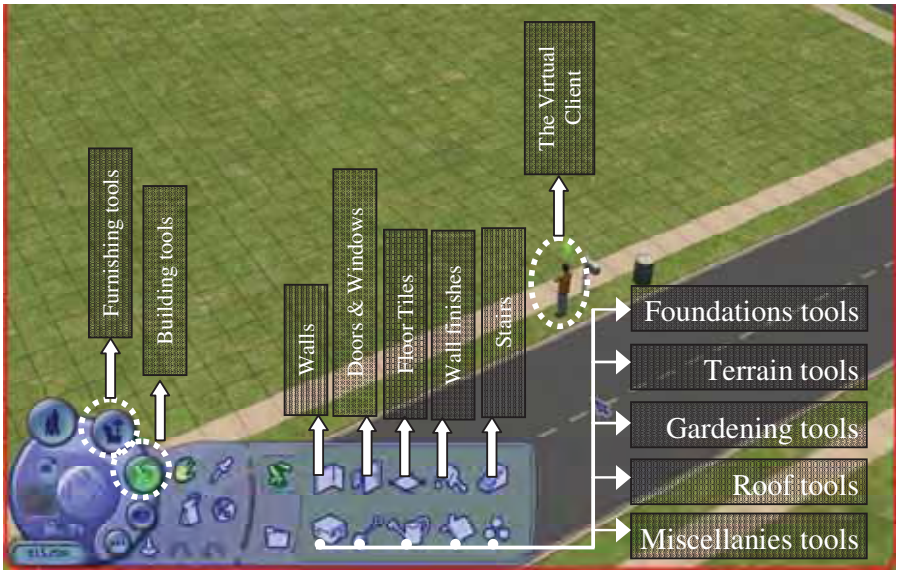

Figure 29: Sims II; Design decisions tools

Figure 30: Sims II; Design Decisions result

Figure 31: Sims II; one of the interactive menus of the game

Expressing the refusal of some one | Screaming for going to W.C. | Asking for making social relationships | Expressing hunger

Figure 32: Sims II; Examples of the character's ability to show out his feelings

4-2-6-The "Why" subject summary:

As illustrated through the previous section, already a game fulfills what is needed in the virtual client. Hence, theoretically this game may be included into a framework to be used for teaching "Knowing Why" issues. This framework, as represented in *Figure 33*, may consist of:

- Knowledge base plug-in: a pluggable patch, which contains facts and rules of a certain community.
- An expert system shell which provides:
  - Inference engine: to infer explanations and facts.
  - Inference control: to provide control of data entry and its validity in relation to domain.
- An interface that is a modified version of this game provides four main elements:
  - Virtual client character.
  - Design decision tools.
  - Evaluation meters.
  - Explanation representation facilities.

Now, think of this scenario, an instructor asks his/her students to design a farm community without any pre-made design program, and asks every student to write down his/her remarks. Therefore, students do various designs and then observe their virtual client interactions with these designs. Students note, write down and analyze the virtual clients reactions towards the designs, and then they start modifying their designs according to their analysis. Once again, they observe their clients interactions with their

modified designs and repeat the cycle. Finally, through this cycle of **action→ review → analysis → planning →action**, and based on their remarks and self-gained experiences, students themselves start to point out what is the architectural typology of the farm community.

In the same way, while playing a funny game and challenging his/her opponents, the player/student may have a self-gained experience about country architecture, desert architecture, buildings for the poor and others.

5-Chapter Five Summary

Through this chapter, chosen commercial games have been investigated to find out how far they fulfill the teaching needs in the shade of the experiential learning. It has been proven that there is a good ability in these games, which are only examples, to be a base to build on for new architectural educational games. And this is what the coming chapter will try to accomplish.

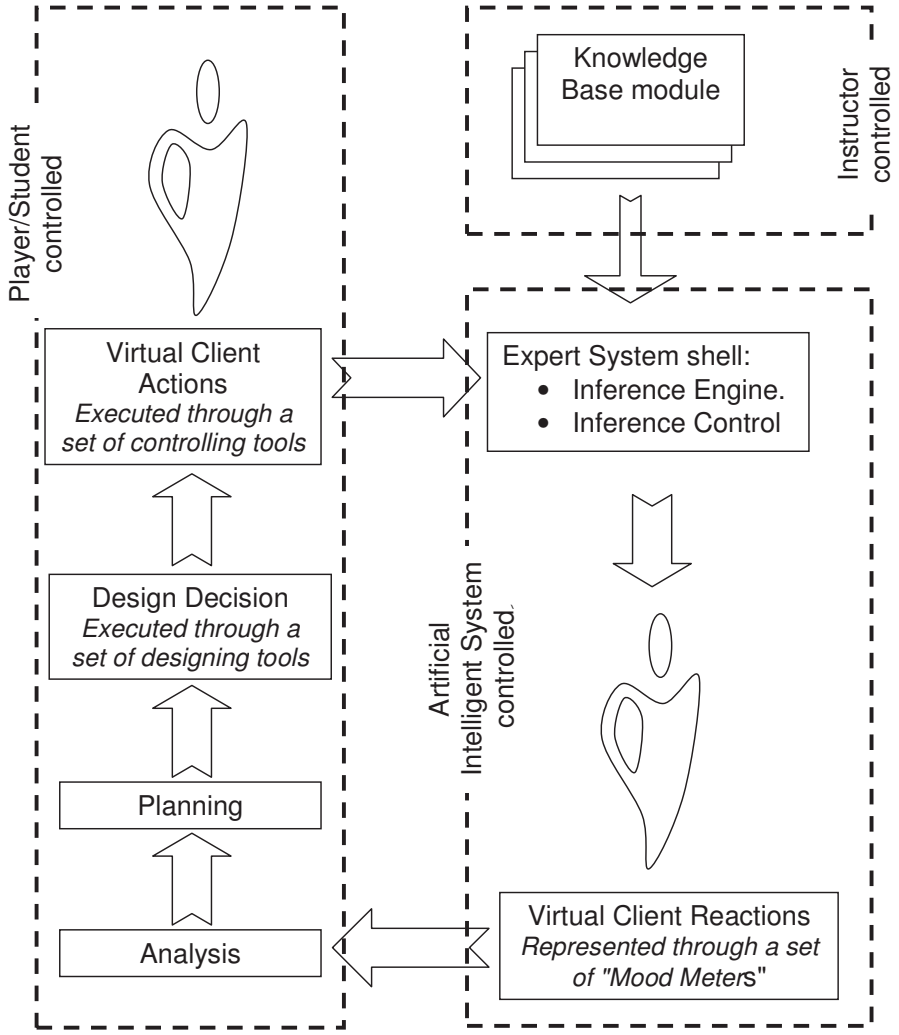

Figure 33: A diagram of the suggested framework for using a Sims II-like game to learn "Why" subjects.

6- Chapter Six: A Game for Teaching Building Construction.

Introduction:

This chapter will draw out a conceptual framework of a game to be used as an educational tool for teaching an architectural course based on the previously mentioned assumptions and theories. The required framework will be accomplished by:

- Choosing an architectural course as a case study to make a conceptual framework of a game that may be used to teach it.
- Pointing out the skills and abilities, in addition to the levels of accomplishment, students should possess by the end of this course.
- Drawing out the course content that will be included into the game.
- Making a conceptual detailed framework of the required game.

1-The Architectural Course:

The "*Building Construction I*" course has been chosen as a case study to apply the approach of using a computer game to teach it. This choice has been drawn because:

- Building construction is one of the architectural subjects that needs to be taught through a "Learning by Doing" approach because, in most of its content, it aims at having the student "Do" something.
- Building construction is somehow a well-defined architectural subject where its outcome product is not subjected to individualistic opinions. This makes any of its tasks like a riddle or a quest the student is asked to solve.
- Building construction is a subject where the trilogy "*What, How and Why*" can be found easily. In such subject, students are asked to accomplish a certain level of knowledge, ability and appreciation of the subject content. This will be discussed in details through the next section.

2-Skills, abilities and accomplishment Level of the course:

To point out which skills and abilities the student should possess by the end of the course, the research will depend on the validation criteria of both RIBA[1] and NAAB[2]. In addition, both of them define the levels of

[1] Royal Institute of British Architects

[2] National Architectural Accrediting Board

achievement required in each skill or ability the student possesses by the end of any course.

2-1-The NAAB levels of accomplishment:

The NAAB criteria[3] encompass two levels of accomplishment:

- **Understanding**: means the assimilation and comprehension of information without necessarily being able to see its full implication.
- **Ability**: means the skill in using specific information to accomplish a task, in correctly selecting the appropriate information, and in applying it to the solution of a specific problem.

For the skills and abilities; the NAAB criteria point out 34 skills and abilities that the graduate student should possess. These skills and abilities are listed and defined in *Appendix 1*

2-2-The RIBA levels of accomplishment:

The RIBA criteria[4] encompass four levels of accomplishment:

- **Awareness**: acquaintance with general concepts, topics, rules, methods or procedures, without necessarily being able to paraphrase or summarize information. Students should be able to identify the limits of their awareness and be able to refer to source material for more in depth knowledge.
- **Knowledge**: familiarity with specific information, including facts, definitions, rules, methods, process or settings, without necessarily being able to see its fullest implication or application.
- **Understanding**: identification, assimilation and comprehension of information. Students can correctly paraphrase or summarize information and can relate it to other material, including its practical application.
- **Ability**: skill in relating specific information to the accomplishment of tasks. Students can correctly select information that is appropriate to a situation and apply it to the solution of specific problems.

[3] NAAB, NAAB Conditions for Accreditation.
http://www.naab.org/usr_doc/2004_CONDITIONS.pdf accessed 13/05/2007

[4] RIBA, Criteria for Validation.
http://www.riba.org/fileLibrary/pdf/CriteriaforValidation1.pdf accessed 13/05/07

In addition, for the skills and abilities, the RIBA criteria point out which skills and abilities should be possessed by the end of each course. These skills and abilities are listed and defined in *Appendix 2*.

2-3-The supposed accomplishment levels of the game:

Investigating both the NAAB and RIBA validation criteria for the accomplishment levels of skills and abilities students should possess by the end of architectural study shows that:

- The NAAB accomplishment levels are insufficient because they neglect the level of knowledge. Although it is a lower level than understanding, knowledge is, in many cases, the only aim of a part of the course content. For Example, in case of the building construction course, one of the main aims of the course is to make the students "Know" the site jargon. In such case, it is a matter of "Knowing" rather than "Understanding". This makes "Knowledge" an important level of accomplishment that should not be neglected.
- For the RIBA accomplishment levels, one may find a gray zone between "Awareness" and "Knowledge", and another between "Knowledge" and "Understanding". Moreover, one may see understanding as a bridging state which enables the student to imply his/her gained knowledge to make a process. In other words there is no true ability without understanding.
- One more thing, both of the two criteria neglect the appreciation state. The appreciation state refers to the student's self-inclination and evaluation of the social value systems. Moreover, it refers to how social communities adapt certain values according to their social value system. In such case, the architectural course tries to plant into the students an appreciation state towards the local and regional value systems especially in societies like ours where the social value systems and heritage are a strong motivator and director.

Hence, the research will use a modified version of accomplishment levels, which fulfills the researcher's point of view of the NAAB and RIBA accomplishment levels and also matches the previously mentioned trilogy "What", "How" and "Why". These levels are:

- **Knowledge:** to know the general concepts, topics, rules, facts, theories, definitions, process or settings, without necessarily being able to see its fullest implication or application.
- **Ability**: to be able to correctly select the appropriate information, and to apply it to the solution of a specific problem. Also the

student should have the ability to indicate if he/she has the appropriate information or he/she needs to search for it to accomplish the task.

- **Appreciation**: to appreciate and value the social value systems, special social heritage, traditions and emotional/psychological needs. In addition, it means to start to adopt certain concepts and inclinations based on the student's self-experience construction.

2-4-The supposed possessed skills and abilities of the game:

Based on the RIBA five thematic headings, "*Building Construction I*" can be classified under the thematic heading "*Technology and Environment*". According to this thematic heading and the list of skills and abilities listed in the NAAB and RIBA validation criteria, one may define the skills and abilities which are supposed to be possessed by the end of such a course. Hence, the game to be designed should develop some/all, which will be indicated later according to the course content, of the skills and abilities that are listed in *Table [6]*. Moreover, the table shows the levels of accomplishment of each skill and ability. The "Appreciation" level of accomplishment, which is suggested by the researcher, does not appear in the table because neither the RIBA nor the NAAB considers it as a levels of accomplishment.

3-The Course content

By investigating and analyzing the course contents of many building construction related courses offered by many architectural schools and universities, see *Appendix 3,* one may point out the main components of the pedagogical curriculum of the game to be:

- The basic building construction systems (bearing walls and skeleton systems).
- The specifications and usage of the main construction materials (wood, brick, stones, OC, and RC).
- The basic and essential building protection (water and heat insulation) and finishing materials.
- The main building components (foundations, walls, slabs, roofs and openings)

Table [6]: Skills and Abilities that are supposed to be implemented into the game

Skill/ability	Description	NAAB	RIBA
Research Skills	**To Do:** gather, assess, record, and apply relevant information in architectural coursework.	**A**	**K**
National and Regional Traditions	**To Know:** the national traditions and the local regional heritage in constructional methods and systems that are relevant to the surrounding environment.	**U**	**K**
Structural Systems	**To Know:** the principles of structural behavior in withstanding gravity and lateral forces and the evolution, range, and appropriate application of contemporary structural systems	**U**	**U**
Building Envelope Systems	**To Know:** the basic principles and appropriate application and performance of building envelope materials and assemblies	**U**	**U**
Building Service Systems	**To Know:** the basic principles and appropriate application and performance of plumbing, electrical, vertical transportation, communication, security, and fire protection systems	**U**	**K**
Building Systems Integration	**To Do:** assess, select, and conceptually integrate structural systems, building envelope systems, environmental systems, life-safety systems, and building service systems into building design	**A**	**A**
Building Materials and Assemblies	**To Know:** the basic principles and appropriate application and performance of construction materials, products, components, and assemblies, including their environmental impact and reuse	**U**	**K**
Construction Cost Control	**To Know:** the fundamentals of building cost, life-cycle cost, and construction estimating	**U**	**K**
Technical Documentation	**To Do:** make technically precise drawings and write outline specifications for a proposed design	**A**	**A**
Architect's Administrative Roles	**To Know:** about obtaining commissions and negotiating contracts, managing personnel and selecting consultants, recommending project delivery methods, and forms of service contracts	**U**	**U**
Architectural Practice	**To Know:** the basic principles and legal aspects of practice organization, financial management, business planning, time and project management, risk mitigation, and mediation and arbitration as well as an understanding of trends that affect practice, such as globalization, outsourcing, project delivery, expanding practice settings, diversity, and others	**U**	**U**
Professional Development	**To Know:** the role of internship in obtaining licensure and registration and the mutual rights and responsibilities of interns and employers	**U**	**K**
Leadership	**To Know:** the need for architects to provide leadership in the building design and construction process and on issues of growth, development, and aesthetics in their communities	**U**	**A**
Legal Responsibilities	**To Know:** of the architect's responsibility as determined by registration law, building codes and regulations, professional service contracts, zoning and subdivision ordinances, environmental regulation, historic preservation laws, and accessibility laws	**U**	**U**

Awareness=**AW**, Knowledge=**K**, Understanding=**U**, Ability=**A**

Now, and based on what have been discussed previously, the research will start, in the coming section, to draw out a conceptual framework of the required game. Before this, it is essential to confirm that the game role in the educational process will not replace the tutor's role. This means the game itself is not sufficient separately to teach the "Building Construction I" course. The game will only facilitate and complete the tutor's role in the educational process. In this case, the tutor's role will be changed from "Telling" the knowledge to "Coaching" and "Explaining" while students are constructing their own knowledge. In addition, the game does not intend to develop any motor skills such as the drafting and drawing skills.

4-The Game; "*The Builder*"

"The Builder" is a third person adventure-like game in which the player/main character is *"Ali"*; an ambitious young man striving to be an authorized builder in a builders community. This community is guided by the historical guild system and based on its rules; to be a master builder, it is a long way of training and practice to finally be accredited. The game tries to involve the player into a pre-designed set of site situations through which he/she would gain the basic knowledge, skills and abilities of small simple building construction.

The game manipulates the basic site situations to be in the form of riddles and puzzles which the player goes through as in adventure games.

4-1-A Narrative Summary

"Ali" is a young man who lives in an imaginary native community where the rules of the guild system are still governing. He dreams about being a "Master Builder" but according to the governing rules, the builders guild governor should accredit him. To achieve this accreditation, he should go through a long way of practice just to be called a "builder" which is the first step of his "Master Builder" career dream.

4-2-Characters of The game

- "*Ali*" is the main character of the game who is controlled by the player. The name is derived from the slogan "pl**A**y to **L**earn arch**I**tecture". The physical characteristics of the avatar are typical to the Egyptian physical characteristics.

- "*A'AM Fathy*" is the help avatar of the game. He is the oldest worker in the group. He does not work with them, as his age and health do not enable him to participate physically. As a

replacement, he offers help for who ever needs it. Whenever the player needs help, he asks him for it. "A'AM Fathy" never tells direct directions or solutions. He embodies clues and hints within historical stories.

- "*The Boss*" is the guide avatar who explains each level narrative context, its limitations, rules and aim. It also judges *Ali's* performance.

- Some secondary avatars that play minor roles in some levels.

4-3-The Game Setting

The game actions are situated mainly into some different construction sites where in each of them *"Ali"* faces a different construction challenge. Passing these challenges one after the other successfully adds points to *Ali's* accreditation score whereas failing adds nothing or decreases his previous score according to the degree of failure and the situation. The game mechanism does not allow the "Undo" option; rather, it offers a chance of fixing the previously made fault as it is exactly in the real situation or offers the chance to start again with the same issue, not the same case, in another construction site. In all cases, the history of *Ali's* trials, successes and failures are all recorded and evaluated. According to this history, *Ali's* performance is evaluated and translated into a rank in the guild system. The final rank of the game is to be a "Builder" that is the first step of being a "Master Builder". The game is only a first phase of a series of sequential games that develop many other skills and abilities for the sake of being a "Master Builder".

4-4-Playing the Game

Playing as *Ali*, the player explores many construction issues that cover different critical construction phases, goes through helping tutorials and educational videos that explain and help the player to solve some construction problems.

To be accredited as a "Builder", the player should go successfully through six basic construction phases that are: Laying foundations, Building walls, Constructing lower floors, Bridging wall openings, Constructing intermediate floors and Constructing final roofs.

After passing these six phases successfully, the final challenge is to choose a structure method and material to construct some different buildings into some different sites. Each of these sites has its own advantages and disadvantages and has its own social and physical context. The player in this challenge is asked to investigate each of these sites and decide which

construction method fits best the situation. After that, he/she chooses one of these sites to participate in the building execution.

At the construction site, when *Ali* is asked to perform a job he has to choose between starting immediately or asking for help. In the second case, he asks the help avatar, "*A'AM Fathy*", who starts to tell him a story about the problem he is challenging and embeds some hints and clues into this story. The help avatar never tells direct solutions unless in case of *Ali's* total failure. The avatar's help is free in the first time of each challenge while further help costs *Ali* score points reduction.

After the completion of each challenge, player is offered the chance to watch a short movie that explains some further facts and information about the completed challenge. Moreover, these movies embody some knowledge and data that will help the student in the final challenge of the game.

4-5-Controls

The game is not supposed to involve special controlling devices. It is supposed to be controlled by an ordinary keyboard and mouse exactly as it is in other adventure games.

4-6-Target Audience

The game mainly targets the first year students in schools of architecture. In spite of this, its adventure-like nature makes it suitable also to other non-architecture students.

4-7-Pedagogical Approach

The pedagogical approach of the game builds on constructivist approaches to instruction where game players learn building construction issues through:

- Exploring virtual but similar to reality construction problems where the player is asked to solve the construction situation successfully by using what is available in the surroundings.
- Going through educational digital tutorials, videos and discussions to search for data, facts, theories and processes. The student here constructs his/her own knowledge via guided navigation into databases and develops a set of different skills and abilities by doing different tasks then observes the outcomes, analyzes them and finally modifies his/her performance.

The game here tries to involve the assumptions that have been raised in the previous chapters of this research which are:

- The usage of verbal and non-verbal contents in the educational tool involves much more of the mental abilities of the students.
- Implying the instruction content within a relevant context, which makes data, facts and knowledge more relevant and logic decreases the students confusion probabilities. This leads to a better ability of drawing mental patterns (schemas) which fasten the knowledge encoding process in the working memory. Hence, a better knowledge gaining/retrieving ability is achieved.
- Implying the complex knowledge domain of the "Building Construction I" course into an engaging frame increases the students involvement and interest which decreases the mental intrinsic cognitive load.
- Although it is a virtual construction site, the player has the chance to explore digitally-created real life site situations where he/she experiences real life problems and tries to solve them and constructs/develops his/her own knowledge and skills by learning from his/her own mistakes.
- Depending on such a game as an educational tool overcomes two main factors that were hampering the experiential learning approach in our architectural schools; the time lack factor and the mistakes implications factor.

4-8-The Game Objectives:

4-8-1-Objectives of the Narrative Context:

Using the guild system rules as a social governing system informs the player indirectly about how the architectural education evolved in the past. In addition, it values the social role of the architectural profession and declares how it affects the social context. Moreover, using a local Egyptian social context as a surrounding context within which the story takes place adds an emotional relation between the player and our local society.

4-8-2-Objectives of the Pedagogical Content:

The pedagogical content of the game may be represented by a spatial matrix (*Figure 34*). On the (X) axis of the matrix there will be the basic construction phases:

- Laying foundations
- Building walls
- Constructing lower floors

- Bridging wall openings
- Constructing intermediate floors
- Constructing final roofs

On the (Y) axis of the spatial matrix there will be the three basic construction materials:

- Brick/Stone
- Wood
- O.C./R.C.

On the (Z) axis there will be the two basic construction systems:

- Bearing walls system
- Skeleton system

Based on this spatial matrix, about 36 different building construction problems should be explored by the end of the game. Each of these problems may have more than one alternative. For example in case of "*using brick/stone to construct a final roof of a bearing wall building*"; in such a case the final roof may be a flat roof by using the Jack Arch system or a curved roof of domes and vaults. Moreover, in case of bridging the wall openings it may be an arch or a flat lintel whatever the construction material is.

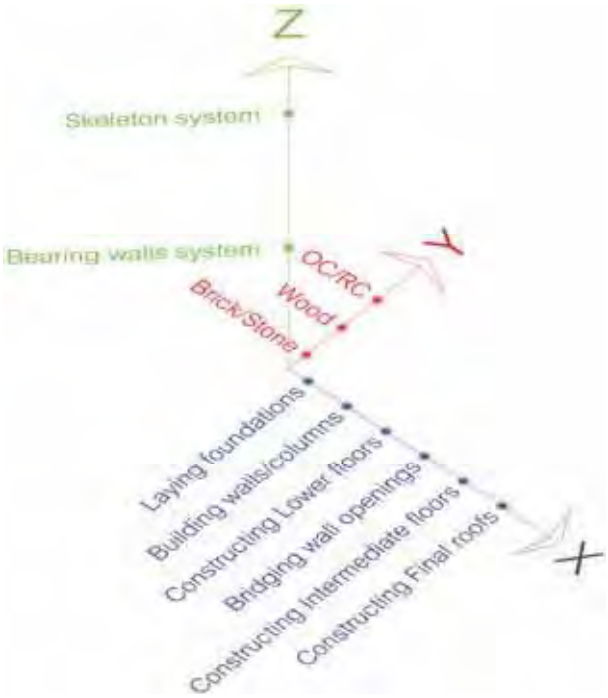

Figure 34: The spatial matrix of the game pedagogical content

On the other hand, some cases in the spatial matrix are not applicable such as the case of "*building a bearing wall that is constructed of wood*". In addition, some cases are similar to each other like the cases of "*constructing the lower floor of a bearing wall building that is constructed of wood*" and "*constructing the lower floor of a skeleton building that is constructed of wood*". Therefore, by eliminating the inapplicable and similar cases in the spatial matrix, only 20 cases remain. These cases are which the player will go through *see Table [7]*.

By dividing the total course of the "Building Construction I" into a set of separated adventure-like tasks, the player is given the ability to explore the course in a non-sequential process. Hence, he/she has the benefits of:

- Constructing his/her own building construction knowledge according to the in-hand situation.
- Dealing with graphical representation of the information rather than the text one.
- Random access of information, like hypertext, rather than "Step by Step" information construction.
- Having instant gratification and frequent rewards
- Developing and applying understandings of building construction concepts, techniques and principles through a virtual construction process.
- In addition, each challenge is designed to transform a certain knowledge, fact, data, concept or technique to the player about a specific construction issue according to the pre-designed curriculum.

4-8-3-Intended Learning Outcomes (ILOs) of the Game:

By the end of the game the player should have achieved the following:

- Developed his/her searching skills and abilities while searching for the hidden clues and hints.
- Developed his/her ability of defining a problem and raising proper questions.
- Developed his/her ability of using precedents while analyzing what the help avatar tells about the past.
- Developed his/her ability of responding to the site conditions.
- Started to construct his/her own appreciation, beliefs and inclinations towards the local traditions of construction methods and their effects on the social context.

Table [7]: The construction issues the player explores while playing the game

#	Construction issue
1.	Laying the foundations of a bearing wall building that is constructed of brick/stones.
2.	Laying the foundations of a skeleton building that is constructed of wood.
3.	Laying the foundations of a skeleton building that is constructed of OC/RC.
4.	Building a bearing wall of brick/stones (Flemish bond, English bond AND flint, random, uncoursed random, coursed random, Kentish rag, uncoursed squared, coursed squared, regular coursed, block in courses, ashlar).
5.	Building a bearing wall of OC/RC (retaining walls)
6.	Building a filling/partition wall of brick/stones.
7.	Building a filling/partition wall of wood.
8.	Constructing the lower floor of a bearing wall building that is constructed of brick/stones (vaulted floor).
9.	Constructing the lower floor of a bearing wall building that is constructed of wood (wooden slab construction).
10.	Constructing the lower floor of a bearing wall building that is constructed of OC/RC.
11.	Bridging wall openings by brick/stones (lintels, arches).
12.	Bridging wall openings by wood (lintels).
13.	Bridging wall openings by OC/RC
14.	Constructing the intermediate floor of a bearing wall building that is constructed of brick/stones (Jack Arch system).
15.	Constructing the intermediate floor of a bearing wall building that is constructed of wood.
16.	Constructing the intermediate floor of a bearing wall building that is constructed of OC/RC
17.	Constructing the intermediate floor of a skeleton building that is constructed of wood.
18.	Constructing the final roof of a bearing wall building that is constructed of brick/stones (domes and vaults).
19.	Constructing the final roof of a bearing wall building that is constructed of wood (raftered roof).
20.	Constructing the final roof of a bearing wall building that is constructed of OC/RC

4-9-The Game Scenario

In the beginning of the game, *the Boss* asks *Ali* to choose a construction problem to start with. Hence, *the Boss* declares the problem narrative and physical context that contain the problem offerings limitations, guiding rules, data and facts.

After that, *Ali* starts to use a set of tools, which will be addressed later, to solve the construction problem. He may ask *A'am Fathi* for help any time while solving the construction problem. When he finishes his solution, he asks *The Boss* to check it.

The Boss checks *Ali's* solution and if it has no faults he declares his success. Else, a callout pops up from the *Bosss* head showing a foreseeing representation about *Ali's* solution implications.

In case of his failure, *Ali* should observe and analyze his solution implications and choose either to fix his solution or to experience another modified version of the same problem, and the cycle goes on. This playing scenario is similar to the experiential learning cycle. *See Figure 35*.

4-10-The Game Structure

The game structure consists of five digital modules that either control the game progress or be controlled by the player. Besides these modules, there are the three main avatars of the game that represent two of the digital modules and the player himself. The game structure, digital modules and avatars roles are represented by *Figure 36*. The following section explains the digital modules roles.

4-10-1-The "Help Material Controller"

This digital module will be responsible for controlling the help content material. It chooses the suitable help material for the in-hand construction problem and prices it. It keeps a record for the previously navigated material for not being offered for free or for the normal cost anymore. This is to ensure the player's seriousness while navigating any help material as it will consume much more extra points if he needs it once again. This digital module will be represented by *A'am Fathi* avatar.

4-10-2-The "Building Blocks"

This module contains the tools that are controlled by the player to solve the construction problem. It offers the basic structural materials, finishing materials, filling materials and complementary systems. the contained material of this module may be changed with other materials by plug-ins. The player controls this module.

4-10-3-The "Analyzer"

This one should be responsible for analyzing the player's solution of the construction problem to find out the week points and faults. The "Analyzer" makes a list of the solution faults and their implications and passes it through to the "Problem Automatic Generator ". The "Problem

Automatic Generator" constructs a foreseeing representation of these implications and uses t*he Boss* avatar to represent it. For example, if *Ali* forgets to waterproof the RC foundations, *the Boss* would represent a foreseeing illustrative film about the steel rods rusting and the foundation failure. Another example; if *Ali* neglects the groundwater pressure effect on the lower floor level, when *the Boss* checks what *Ali* has done, a foreseeing illustrative film pops out from the Bosss head showing the implications of this fault. This scenario of representing the fault implications gives the player the ability of analyzing his/her solution by himself to find out the faults he/she had done which develop his/her ability of critical thinking.

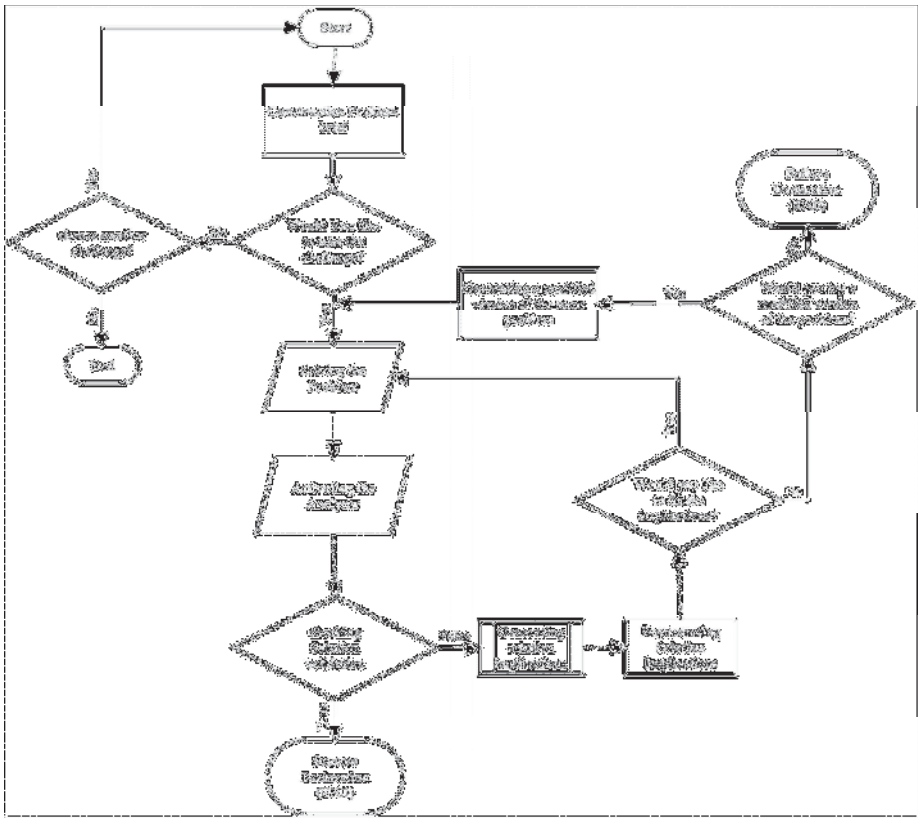

Figure 35: Game Playing Scenario Flowchart

4-10-4-The "Problem Automatic Generator"

At the beginning of the game, there would be many preset construction problems or scenarios. The player would have the ability to start playing with any of them. The "Problem Automatic Generator" role starts

when it receives, from the "Analyzer" module, a list of faults that are found in the player's suggested solution. In this case, it generates a foreseeing illustrative film about the implications of the player's suggested solution. It represents this film as a callout that pops out from the Bosss head.

In addition, it would be responsible for generating a modified version of the in-hand construction problem when the player chooses to do so in place of fixing his/her solution implications. Moreover, it would be responsible for generating automatically the four sites and the three clients in the final challenge. This generation bases on a list of choices to choose from. The choices should contain all the cases that have been explored while playing the game. The Boss avatar will represent this digital module.

4-10-5-The "Player's Performance Tracker"

This one will be responsible of tracking and recording the player's performance and actions. Each action, decision, trial, failure and success the player has mad should be recorded and evaluated by the end of the game. In addition, the player should be provided a full report to be aware of his/her performance. This module will be represented by a "Performance Meter" which will provide a glance about the player's score.

4-11-The "Game Interface"

The game interface facilitates the interaction between the player and the game. Its components represent the givens and options that the game offers to the player. It also represents the 3D environment within which the player performs his/her actions. In addition, it constructs the channel through which the game represents its reactions and the player's actions implications. Hence, the game interface components are:

4-11-1-The "Help Activator"

The player uses this trigger to ask *A'am Fathi* for help. Whenever the player needs help, he/she clicks the *A'am Fathi* avatar to activate it for help.

4-11-2-The "Analyzer Activator"

The player uses this trigger to declare that he/she finished solving the construction problem. By Clicking *the Boss* avatar, the player activates the "Analyzer" module to start analyzing and evaluating his/her solution.

4-11-3-The "Implications Representative"

This is where the implications of the solution faults are illustrated. After *the Boss* checks *Ali's* solution, a callout pops out from his/her head illustrating a foreseen representation about the fault implications.

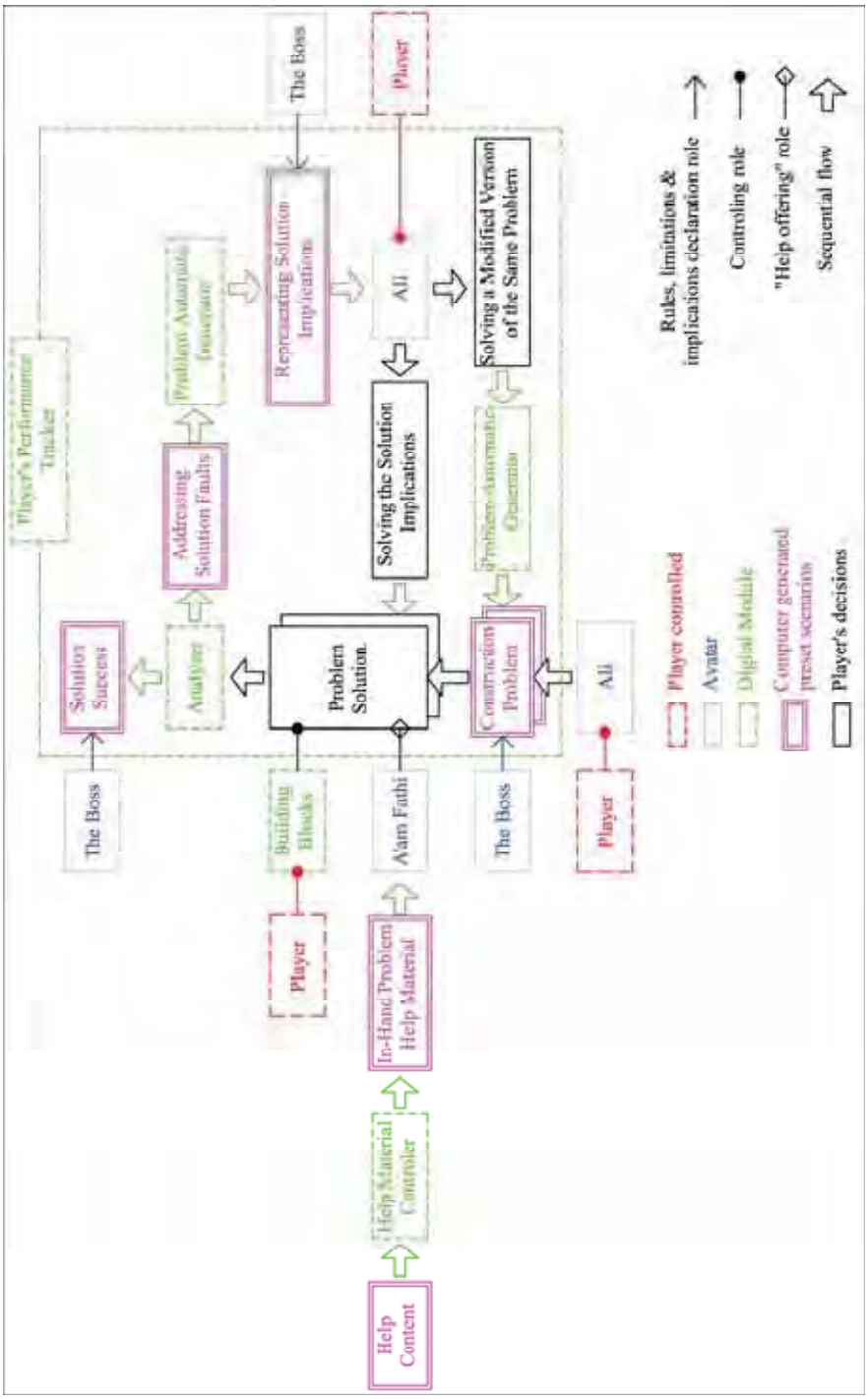

Figure 36: Game Structure Diagram

4-11-4-The "Performance Meter"

It is a graphical representation of the player's performance. Whenever it has been clicked, a detailed report about the player's performance is provided.

4-11-5-The "Problem Solving 3D environment"

The normal scene of the game is the "Third Person" scene or a bird eye view perspective where the player can explore the surrounding context and the total environment of the construction site. By clicking on the excavated construction site itself, the display mode changes to the problem solution mode. This mode is a 3D environment where the scene is a "First Person" scene or a normal eye view perspective and the cursor changes to be a hand to start using the "Building blocks" tools to solve the construction problem.

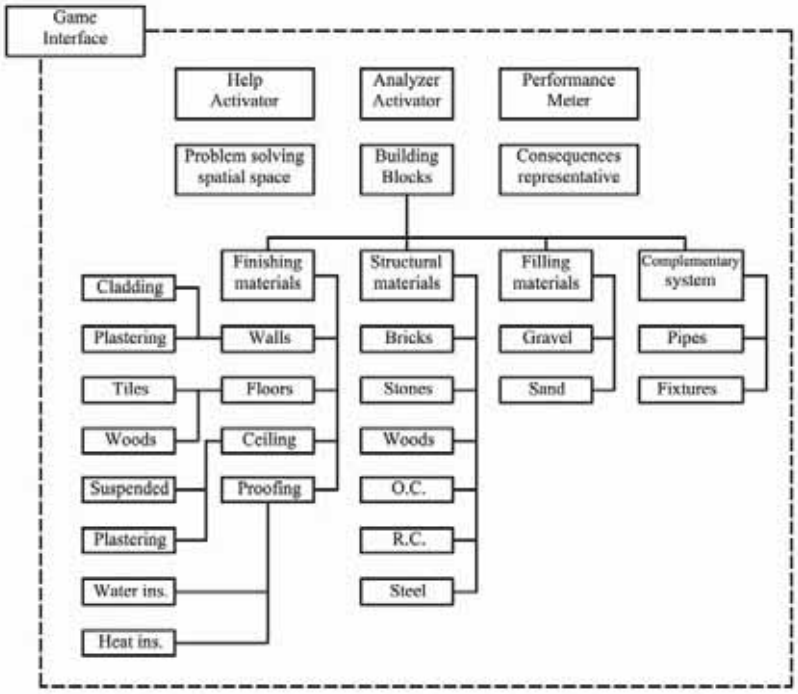

Figure 37: The Game Interface Components

4-12-The Game Levels:

This section will describe briefly the game levels. The description will point out eight main issues, which are:

- The construction problem that is explored in the level.

- The narrative context of the level.
- The physical context of the level.
- Help content and material.
- Player's performance assessment criteria.
- What is the "knowledge" the player is supposed to gain by the end of the level.
- What skills and abilities the player is supposed to develop directly by the end of the level.
- What skills and abilities the player is supposed to develop indirectly by the end of the level.

4-12-1-Issue one: "Help workmate to build his own house".

The level construction problem:

Laying the foundations of a bearing wall building that is constructed of brick/stones.

The level narrative context:

Ali's workmate is going to be married. The guild master decided to help him to build his own home as a marriage gift. The whole group of builders went to the house location to participate in constructing it. *Ali* is asked to help by laying the foundations of a wall.

The level physical context:

The site is already excavated. The building is a one story building and the ground floor is 30 cm above zero. No basement is required. The building location is nearby a cultivated land. Brick will be the construction material. Soil bearing capacity and the wall transferred loads will be given.

Help content and material:

- Schematic charts, data sheets and sketches about the soil bearing capacity.
- A film about camel feet will be used to represent the theory and rules of distributing loads.
- An illustrative film about how we can keep a table with thin legs stable on sandy ground.
- A documentary film about how we can lay brick foundations.

Player's performance assessment criteria:

The first assessment criterion will be how far the player goes with the help material before he/she gets the right solution. Moreover, did he/she manage to lay the foundations conceptually and mathematically correct?

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know what the foundation level and the soil bearing capacity mean.
- Know the theory and rules of distributing loads according to the soil bearing capacity.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Lay the foundations of a bearing wall when both of the soil bearing capacity and the walls transferred loads are given

Indirect skills and abilities to be developed:

By the end of this level and initiated by the narrative context and the indirect help methodology, the student should start to:

- Develop his/her ability of analyzing data and information.
- Appreciate the concept of "*community cooperation*" as a native behavior.

4-12-2-Issue two: "Boss asks for a wooden shelter".

The level construction problem:

Laying the foundations of a skeleton building that is constructed of wood

The level narrative context:

"We are moving to a new construction site location." Boss said. "The place is so hot and windy and we will stay there for about two months. So the first thing we will build is a wooden shelter to accommodate us. *Ali,* you are required to lay the foundations."

The level physical context:

The site is already excavated. The building is a one story building and the ground floor is 30 cm above zero. No basement is required. The building location is in the desert. Wood will be the construction material. Soil bearing capacity and the column transferred loads will be given.

Help content and material:

- Schematic charts, data sheets and sketches about the soil bearing capacity.
- A film about camel feet will be used to represent the theory and rules of distributing loads.

- An illustrative film about how we can keep a table with thin legs stable on sandy ground.
- A documentary film about how we can lay wooden column foundations.

Player's performance assessment criteria:

The first assessment criterion will be how far the player goes with the help material before he/she gets the right solution. Moreover, did he/she manage to lay the foundations conceptually and mathematically correct?

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know what is meant by the foundation level and the soil bearing capacity.
- Know the theory and rules of distributing loads according to the soil bearing capacity.
- Know about curing wood against insects.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Lay the foundations of a wooden column when both of the soil bearing capacity and the columns transferred loads are given

Indirect skills and abilities to be developed:

By the end of this level and initiated by the narrative context and the indirect help methodology the student should start to:

- Develop his/her ability of analyzing data and information
- Appreciate the concept of "*workers safety comes first*" as a work moderator.

4-12-3-Issue three: "Building the village school".

The level construction problem:

Laying the foundations of a skeleton building that is constructed of OC/RC

The level narrative context:

"Ok, as you know boys our village needs a school" said the Boss. "Our beloved mayor will construct one for us and he hired us to help. Let us do it"

The level physical context:

The site is already excavated. The building is a multi story building and the ground floor is 120 cm above zero. A basement is required. The

building location is nearby a cultivated land. The building will be a RC skeleton building with bricks as a filling material. The groundwater table level will be given.

Help content and material:

- Schematic charts, data sheets and sketches about the soil bearing capacity.
- A film about camel feet will be used to represent the theory and rules of distributing loads.
- An illustrative film about how we can keep a table with thin legs stable on sandy ground.
- A documentary film about how we can lay RC column foundations.
- A documentary film about how we can waterproof the RC foundations.
- An illustrative film about the role of steel rods in the RC.

Player's performance assessment criteria:

The first assessment criterion will be how far the student goes with the help material before he/she gets the right solution. Moreover, did he/she manage to lay the foundations conceptually and mathematically correct?

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know about stresses and strains in structural elements, states of stress (shear, bending, torsion)
- Know what is meant by the foundation level and the soil bearing capacity.
- Know the theory and rules of distributing loads according to the soil bearing capacity.
- Know the theory and rules behind using steel rods in the RC.
- Know the groundwater effect on the RC.
- Know about waterproofing materials

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Lay the foundations of a RC column when both of the foundation level and dimensions are given.

Indirect skills and abilities to be developed:

By the end of this level and initiated by the indirect help methodology, the student should start to:

- Develop his/her ability of analyzing data and information.

4-12-4-Issue four: "*Training field*".

The level construction problem:

To use brick to build bearing walls using the Flemish bond and the English bond orders. Moreover player will use stones to build walls using the flint, random, uncoursed random, coursed random, Kentish rag, uncoursed squared, coursed squared, regular coursed, block in courses and ashlar orders.

The level narrative context:

It is the training time. Boss is preparing fresh men to catch their career. *Ali* is asked to build as much walls as he can but he should be sure that they are stable enough to stand against vibrations.

The level physical context:

The site is near a railway line so every time the train comes, it causes a lot of earth vibrations which is similar to earthquakes. The player is supposed to start building his wall from above the zero level, so foundations are already laid. Stones and bricks are available and the player should use them to build walls.

Help content and material:

- An illustrative film about the lateral forces effect on walls.
- An illustrative film about earthquake forces.
- An illustrative film analyzes the walls failure.
- Documentary pictures of the bricks bonds and masonry bonds.

Player's performance assessment criteria:

In this issue the player's assessment criterion will be how many walls are built in how much time. Help will be for free and cost nothing as it is a training session and also timer will be stopped while getting help.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know static and dynamic loads on buildings, and earthquakes effects.
- Know ordinary brick dimensions.
- Know masonry and brick bonds.
- Know site language "Jargon" that is related to brick and masonry work like stretcher, header, closer, bonder…etc.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Construct different kinds of bearing walls by either bricks or stones.

Indirect skills and abilities to be developed:

By the end of this level and initiated by the narrative context, the "*for free*" help methodology and the assessment mechanism, the student should start to:

- Appreciate the importance of training.
- Appreciate the concept that using help to accomplish a mission costs much more less than making mistakes.

4-12-5-Issue five: "*Basement*".

The level construction problem:

To use the RC to build a retaining wall.

The level narrative context:

It is the village school building again. It is required to start constructing the basement walls. *Ali* is in charge and he should do the 4 surrounding walls of the basement.

The level physical context:

The site is already excavated. The building is a multi story building. The basement clear height is 4.5 meters. Its finish floor level is 3m below the zero level. The building is adjacent to one of the land edges. The building location is near a cultivated land. Walls of the basement will be RC. The groundwater table level will be given.

Help content and material:

- Schematic charts, data sheets and sketches about the soil lateral forces.
- An illustrative film about the different types of retaining walls.
- An illustrative film about the role of steel rods in the RC.
- A documentary film about waterproofing the RC foundations.

Player's performance assessment criteria:

The first assessment criterion will be how far the student goes with the help material before he/she gets the right solution. Moreover, did he/she manage to construct the retaining wall conceptually correct?

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know the theory and rules behind using steel rods in the RC.
- Know the groundwater effect on the RC.

- Know about waterproofing materials
- Know the theory and rules behind retaining soil and levels differences.
- Know about different kinds of retaining walls.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Choose, construct and waterproof the suitable RC retaining wall that suits the building situation.

Indirect skills and abilities to be developed:

By the end of this level and initiated by the physical context, the student should start to:

- Develop his/her ability of matching between limitation and offerings of a situation and the corresponding available solutions to choose the most suitable one.

4-12-6-Issue six: "Help neighbor to divide a room".

The level construction problem:

To build a partition wall using bricks.

The level narrative context:

Ali's neighbor has asked him for help. He needs to divide one of his rooms into two spaces. He asked *Ali* to do it fast, stable and cheap. *Ali's* reputation as a future builder is in context. Would he succeed?

The level physical context:

The main building is a skeleton system building but the neighbor does not know, the space to be divided is in the second floor, only bricks are available.

Help content and material:

- Schematic sketches about the visual indicators of each structure system type.
- An illustrative film about how loads are transferred in the skeleton system.
- A documentary film about constructing partition walls with bricks.

Player's performance assessment criteria:

The first criterion will be his/her success in indicating the construction system of the building supporting his/her suggestion with visual evidences. The second criterion will be his/her success in choosing the most

appropriate brick type to be used in building the wall according to the needs of the wall and the specifications of the available materials. The third criterion will be the player's success in constructing the cheapest stable partition wall with the minimum amount of brick.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know about different brick types according to their usage and manufacturing components

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Use visual indicators to guess the structural system of an existing building.
- Evaluate different available materials according to their specifications to match between the needs and their specifications.
- Construct a partition wall with bricks.
- Check the brick quality (dimensions, cracks,…etc.)

Indirect skills and abilities to be developed:

By the end of this level and initiated by the physical context, the student should start to:

- Develop his/her ability of matching between limitations and givens of a situation and the corresponding available solutions to choose the most suitable one.
- Appreciate the concept of "specialized information importance" and how it affects decisions efficiency.

4-12-7-Issue seven: "Divide the shelter".

The level construction problem:

To build a partition wall using wood.

The level narrative context:

The Boss asked *Ali* to divide the wooden shelter into two spaces, one for sleeping and the other for eating. Wood is still the only available material. *Ali* has to do it right or he may lose more than his career.

The level physical context:

The exterior walls and roofs have been built. The building is a one-story building and the ground floor is 30 cm above zero. The finish floor is a wooden cheap tile. The required partition will reach the ceiling.

Help content and material:

- Schematic sketches about the concept of cladding a structure with other materials.
- A documentary film about constructing a wooden partition.

Player's performance assessment criteria:

The first assessment criterion will be how far the student goes with the help material before he/she gets the right solution. Moreover, did he/she manage to construct the partition conceptually correct?

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know the ordinary local wood dimensions and suitable spans.
- Know site language "jargon" that is related to carpentry work like studs, posts …etc.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Construct wooden partitions

Indirect skills and abilities to be developed:

N/A.

4-12-8-Issue eight: "*River flood*".

The level construction problem:

Constructing the lower floor of a bearing wall building that is constructed of brick or stones by using vaults.

The level narrative context:

Ali's friend "*Abdel Rahman*" is from Sudan. He was talking with *Ali* about how much he feels sad because his house has been damaged because of the river flood. *Ali* felt sad for his friend and wished to find a way to help him. He slept and dreamed about a solution, will it be a nice dream or a nightmare?

The level physical context:

The building location is nearby a flooding river. When it floods the water level becomes about 50 cm above the zero level. Only stones and bricks are available to construct the building. The building height will be one story.

Help content and material:

- An illustrative film about the theory and rules of transferring loads into curved surfaces.

- A documentary film about the construction of a vault.

Player's performance assessment criteria:

The assessment criterion will be based on the player's success in constructing a stable, waterproofed, flat finish floor of the house which avoids and resists the river flood effect.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know about waterproofing materials.
- Know about some of the finish floor tiles.
- Know the theory and rules behind transferring loads by single curvature surfaces.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Use shallow vaults which base on side walls to construct flat, waterproofed, and raised above zero ground floor surface

Indirect skills and abilities to be developed:

N/A.

4-12-9-Issue nine: "*River flood II*".

The level construction problem:

Constructing the lower floor of a bearing wall building where the floor is constructed of wood (wooden slab construction).

The level narrative context:

Once again, it is the river flood. *Abdel Rahman's* house is safe but he still feels sad because his brother's house, *Mahdy*, is not. *Abdel Rahman* called *Ali* for a solution as the previous solution does not fit in this case. *Mahdy* has not enough bricks or stones to construct vaults. What he has is only enough to construct a few short walls. But on the other hand he has plenty of wood. *Abdel Rahman* sent asking *Ali* if he has a wooden solution for the situation.

The level physical context:

The building location is nearby a flooding river. When it floods the water level becomes about 50 cm above the zero level. A few amount of brick is available and plenty of wood to construct the building. The building height will be one story.

Help content and material:

- Schematic sketches about the concept of cladding a structure with other materials.
- Data sheets about wood dimensions and bearing stresses.
- A documentary film about constructing a wooden floor.

Player's performance assessment criteria:

The assessment criterion will be based on the player's success in constructing a stable, waterproofed, flat finish floor of the house which avoids and resists the river flood effect.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know the ordinary local wood dimensions and suitable spans.
- Know site language "jargon" that is related to carpentry work like studs, posts …etc.
- Know about using air ventilation to resist the moisture effect on the wood.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Use wooden construction that bases on side brick\masonry walls to construct flat, waterproofed, and raised above zero ground floor surface.

Indirect skills and abilities to be developed:

N/A.

4-12-10-Issue ten: "Help workmate II".

The level construction problem:

Constructing the lower floor of a bearing wall building where the floor is constructed of OC/RC.

The level narrative context:

Ali is still helping his workmate to build his house. The Boss now asked *Ali* to construct floor of the ground floor. Once again *Ali's* career is being tested, would he succeed?

The level physical context:

Exterior and interior walls have been built starting from foundations to the zero level. The building is a one-story building and the ground floor is 30 cm above zero. No basement is there. The building location is nearby a

cultivated land. Walls were built using bricks as a construction material. OC will be used to construct floor of the ground floor.

Help content and material:

- Schematic charts and data sheets about the groundwater upward pressure.
- A documentary film about waterproofing the OC layer of the ground floor.

Player's performance assessment criteria:

The assessment criterion will be based on the player's success in constructing a stable, waterproofed, flat finish floor of the house.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know about waterproofing materials.
- Know about the groundwater pressure.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Construct a waterproofed OC layer as a floor of the ground floor.

Indirect skills and abilities to be developed:

N/A.

4-12-11-Issue eleven: "*Site visits*"

The level construction problem:

To use lintels and arches for bridging wall openings with bricks/stones, wood and OC/RC as construction materials.

The level narrative context:

Ali decided to take a tour between all sites he participated in previously. Surprisingly, he found the same problem in each site; who are there do not know how to bridge a wall opening. Doors and windows are awaiting there for a solution to be bridged. *Ali* is asked for a solution. Would he offer one for each case?

The level physical context:

The available construction material in each case; brick, stones, wood or OC/RC should be used. The wall openings widths are different and according to each one width, available construction material and the surrounding context will be the solution.

Help content and material:

- Documentary pictures about arch types.
- An illustrative film about the theory and rules of transferring loads by curved and flat statically systems.
- A documentary film about arches and lintels construction.
- Schematic sketches about laminated beams and composed sections.

Player's performance assessment criteria:

The first assessment criterion will be according to how far the student went through the help material. The second criterion will be how many different valid solutions the player provided and how far each one of them was appropriate to its surroundings.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know about arch types and spans that matches each type.
- Know the site language "jargon" that is related to arches and lentils such as keystone, voussoirs, Springer…etc

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Use different materials, bricks, stones, wood and OC/RC, to bridge wall openings using arches and lentils.

Indirect skills and abilities to be developed:

By the end of this level and initiated by the narrative and physical contexts, the student should start to:

- Appreciate the concept of "*matching the surrounding architectural context*" as an architect's important duty.

4-12-12-Issue twelve: "*Anti Monopoly*".

The level construction problem:

Constructing the intermediate floor of a bearing wall building that is constructed of brick/stones by the Jack Arch system.

The level narrative context:

It is the time of constructing an intermediate floor slab of a bearing wall building but there is a major problem. Suddenly, prices of the steel increased about 20% because of a monopoly action. *Boss* feels so bad and because of this increase he will lose much more money than he can afford. The amount of steel rods he can afford, according to the new prices, is not

enough to construct the needed RC slab. In addition, wood as a construction material is not available in this case. *Boss* has to choose between two options; either loses his money or loses his reputation but *Ali* has another plan. Would he succeed?

The level physical context:

The building is a bearing wall building. The slab to be constructed is 5.00 meters above zero. The amount of steel rods that are available is only enough to form few small beams. A junior civil engineer is available to help *Ali* to calculate any structural calculations. Brick is available abundantly and the total legal height of the building will be given.

Help content and material:

- An illustrative film about the theory and rules of transferring loads into curved surfaces.
- A documentary film about the construction of a vault.

Player's performance assessment criteria:

The main assessment criterion will be based on the player's success to construct the cheapest floor which is flat, safe and does not consume much of the available height.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know about the Jack Arch system.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Use the Jack Arch system to construct a flat roof as a replacement of the RC slab.

Indirect skills and abilities to be developed:

By the end of this level and initiated by the narrative context, the student should start to:

- Appreciate the concept of "*The architect's role to lead the community and facilitate its needs*".
- Appreciate the need of innovative construction methods that suit the physical local context offerings and the community needs to resist the monopoly action of some industrial organizations which causes troubles and difficulties to small sized contractors and local native communities.

4-12-13-Issue thirteen: "*Anti Monopoly* II".

The level construction problem:

Constructing the intermediate floor of a bearing wall building that is constructed of wood

The level narrative context:

Steel prices are still high. Although it is a new site, but the situation is the same; Boss has no enough money to build the intermediate floor. The only difference here is that wood is available to be used as a construction material.

The level physical context:

The building is a bearing wall building. The slab to be constructed is 5.00 meters above zero. There are no steel rods available at all. A junior civil engineer is available to help *Ali* to calculate any structural calculations. Wood is available abundantly and the total legal height of the building will be given.

Help content and material:

- Schematic sketches about the concept of cladding a structure with other materials.
- Data sheets about wood dimensions and bearing stresses.
- A documentary film about constructing a wooden floor.

Player's performance assessment criteria:

The assessment criterion will be based on the player's success in constructing a stable, flat intermediate floor.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know the ordinary local wood dimensions and suitable spans.
- Know site language "jargon" that is related to carpentry work like studs, posts …etc.
- Know about on-wood plastering requirements.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Use wooden construction that bases on side brick\masonry walls to construct flat intermediate floor slab.
- Clad the lower surface of a wooden intermediate floor slab to be plastered.

Indirect skills and abilities to be developed:

By the end of this level and initiated by the narrative context, the student should start to:

- Appreciate the concept of "*The architect's role to lead the community and facilitate its needs*".
- Appreciate the need of innovative construction methods that suit the physical local context offerings and the community needs to resist the monopoly action of some industrial organizations which causes troubles and difficulties to small sized contractors and local native communities.

4-12-14-Issue fourteen: "Anti Monopoly success"

The level construction problem:

Constructing the intermediate floor of a bearing wall building that is constructed of OC/RC

The level narrative context:

They got the message. Steel prices decreased and they are within the range now. It is another bearing wall building and an intermediate floor would be constructed but this time it would be a RC slab.

The level physical context:

The building is a bearing wall building. The slab to be constructed is 5.00 meters above zero. RC will be used as a construction material. A junior civil engineer is available to help *Ali* to calculate any structural calculations. The slab would have a bathroom above one of its corners.

Help content and material:

- Schematic sketches about different kinds of RC slab systems.
- An illustrative film about the role of steel rods in the RC.
- Schematic sketches about the bathroom installations piping.

Player's performance assessment criteria:

The assessment criterion will be based on the player's success in constructing a stable, flat finish floor suitable to accommodate a bathroom above a certain spot on it.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know about waterproofing materials.
- Know about the water supplying and sanitary systems.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Construct an Intermediate RC slab.
- Waterproof a bathroom floor.
- Pipe the bathroom installations

Indirect skills and abilities to be developed:

N/A.

4-12-15-Issue fifteen: "Mezzanine in the shelter".

The level construction problem:

Constructing the intermediate floor of a skeleton building that is constructed of wood.

The level narrative context:

Once again it is the wooden shelter. Workers need an additional space to be added in the shelter. Thanks God the shelter height can afford a mezzanine space. Boss asked *Ali* to build the mezzanine.

The level physical context:

The mezzanine finish floor level is 3 meters above the finish floor of the shelter level. Only wood are available to construct the mezzanine. Column spans are wide so using wooden trusses and composite beams is necessary.

Help content and material:

- An illustrative film about trusses and their statical systems.
- An illustrative film shows how skin clad body skeleton.
- Data sheets about wood dimensions and bearing stresses.
- A documentary film about constructing a wooden floor.

Player's performance assessment criteria:

The assessment criterion will be based on the player's success in constructing a stable, flat wooden mezzanine floor.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know the ordinary local wood dimensions and suitable spans.
- Know site language "jargon" that is related to carpentry work like studs, posts …etc.
- Know about the theory and rules of trusses and composite beams.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Use wooden trusses and composite beams that base on wooden skeleton to construct flat mezzanine floor slab.

Indirect skills and abilities to be developed:

N/A.

4-12-16-Issue sixteen: "Help workmate III".

The level construction problem:

Constructing the final roof of a bearing wall building that is constructed of bricks/stones (domes and vaults)**.**

The level narrative context:

Construction is going to be finished. Now it is the final stage of building the workmate's marriage house. *Ali* is still helping and this time he has to construct the domes and vaults that cover the building spaces.

The level physical context:

Exterior and interior walls have been built. The building is a one story building and the ground floor is 30 cm above zero. Walls were built using bricks as a construction material. In addition, domes and vaults will be used to cover the building spaces. All needed dimensions will be provided in each case separately.

Help content and material:

- An illustrative film about the theory and rules of transferring loads into curved surfaces.
- A documentary film about the construction of a vault
- A documentary film about the construction of a dome.

Player's performance assessment criteria:

The assessment criterion will be based on the player's success in constructing a stable final roof of the house by using domes and vaults.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know about the theory and rules behind using curved surfaces to cover spaces.
- Know the site language "jargon" that is related to domes and vaults.
- Know about different types of domes and vaults and their construction requirements

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Construct domes and vaults to cover spaces

Indirect skills and abilities to be developed:

N/A.

4-12-17-Issue seventeen: "Finishing the shelter".

The level construction problem:

Constructing the final roof of a bearing wall building that is constructed of wood (raftered roof)

The level narrative context:

Construction is going to be finished. Now it is the final stage of building the wooden shelter. *Ali's* role is to construct the final roof.

The level physical context:

The building walls are already constructed. The building location is in the desert. Wood will be the construction material. The column spans are wide.

Help content and material:

- An illustrative film about trusses and their statical systems.
- An illustrative film shows how skin clad body skeleton.
- Data sheets about wood dimensions and bearing stresses.
- A documentary film of constructing wooden inclined roofs.

Player's performance assessment criteria:

The assessment criterion will be based on the player's success in constructing a stable final roof of the shelter by using wood.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know the theory and rules of the wooden truss systems.
- Know the site language "jargon" that is related to wooden trusses.
- Know about different types of wooden trusses and their construction requirements.
- Know some of heat insulation materials.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Use wood to construct inclined roofs to cover spaces.

Indirect skills and abilities to be developed:

N/A.

4-12-18-Issue eighteen: "Finishing the school building"

The level construction problem:

Constructing the final roof of a bearing wall building that is constructed of OC/RC

The level narrative context:

Construction is going to be finished. Now it is the final stage of building the village school. *Ali's* role is to construct the final roof.

The level physical context:

The building is already constructed; it is only the final roof that is remaining. The building location is nearby a cultivated land. The RC will be used as a construction material. The final roof has to be proofed against water and heat.

Help content and material:

- Schematic sketches about different kinds of RC slab systems.
- An illustrative film about the role of steel rods in the RC.
- A documentary film about constructing RC slabs and executing the waterproof and heat insulation courses.

Player's performance assessment criteria:

The assessment criterion will be based on the player's success in constructing a stable, final RC roof which is proofed against water and heat.

"Knowledge" to be gained:

By the end of this level, the student is supposed to:

- Know some of heat insulation materials.
- Know about waterproofing materials.

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Construct and insulate a final RC slab.

Indirect skills and abilities to be developed:

N/A.

4-12-19-The final challenge: "Accreditation exam"

The level construction problem:

To involve all what have been learnt.

The level narrative context:

Now it is the time of accreditation. It is a matter of "*to be or not to be*". Boss decided to have *Ali* face his final challenge. There are four available construction sites; each of them has its own characteristics, offerings and limitations. In addition, there are three clients; each of them has his own needs and abilities. *Ali* is asked to investigate each site and meet each client and based on his investigations and meetings he is supposed to decide which project will be assigned to which site and how it will be constructed; construction system and construction materials. Then *Ali* is supposed to choose one of the three projects to take full control on it and built it totally without any help.

The level physical context:

The physical context of each construction site will be randomly generated by a digital mechanism which will choose randomly from a list of physical context characteristics.

Help content and material:

N/A

Player's performance assessment criteria:

The assessment criteria will be based on:

- How far the site investigation was fruitful.
- How far the client meeting was fruitful.
- *Ali's* success to assign each project to the most appropriate site based on the client needs and abilities and site offerings and limitations.
- How far *Ali* succeeded to construct the project he has chosen.

"Knowledge" to be gained:

N/A

Direct skills and abilities to be developed:

By the end of this level, the student should be able to:

- Plan for a site investigation.
- Plan for a client meeting.

Indirect skills and abilities to be developed:

By the end of this level, the student should start to:

- Develop his/her ability of future planning.

4-13-The Game Educational Final Gain:

By the end of the game the player should gain, construct, develop and appreciate a set of data, information, theories, skills, abilities and concepts. Based on the research trilogy of accomplishment levels "Knowledge", "Ability" and " Appreciation", they can be listed as follows:

4-13-1-Knowledge:

1) To know the theory and rules of/behind :
   a) Distributing loads according to the soil bearing capacity.
   b) Using steel rods in the RC.
   c) Static and dynamic loads on buildings, and effects of earthquakes.
   d) Stresses and strains in structural elements, states of stress (shear, bending, torsion)
   e) Retaining soil and levels differences.
   f) Transferring loads by single/double curvature surfaces.
   g) Wooden trusses systems and composite beams.
2) To know the site language "jargon" that is related to:
   a) Arches and lentils.
   b) Domes and vaults.
   c) Brick and masonry work.
   d) Carpentry work.
   e) Wooden trusses.
3) To Know about the materials of:
   a) Water proofing materials.
   b) Heat insulation materials.
   c) Different brick types according to there usage and manufacturing components and ordinary brick dimensions.
   d) Wood and its dimensions and suitable spans.
   e) Finish floor tiles.
4) To know about the systems and different types of:
   a) Masonry and brick bonds.
   b) Retaining walls.
   c) Arches and lentils types and spans that match each type.
   d) The Jack Arch system.
   e) Wooden trusses and their construction requirements.

f) Water supplying and sanitary systems.
g) Domes and vaults and their construction requirements

4-13-2-Ability:

1) To lay the foundations of:
   a) A bearing wall when both of the soil bearing capacity and the walls transferred loads are given.
   b) A wooden column when both of the soil bearing capacity and the columns transferred loads are given.
   c) A RC column when both of the foundation level and dimensions are given.
2) To construct a wall that is:
   a) A bearing wall by bricks.
   b) A bearing wall by stones.
   c) A partition wall by bricks.
   d) A partition wall by wood.
3) To construct and waterproof a RC retaining wall.
4) To check the brick quality (dimensions, cracks…etc
5) To construct flat slab by using:
   a) Shallow brick vaults.
   b) Wooden construction.
   c) OC/RC slabs
6) To waterproof :
   a) The bricks/stones foundations.
   b) The RC foundations and buried elements.
   c) The ground floor.
   d) The retaining walls.
   e) The bathroom floor.
   f) The final roof RC slab.
7) To protect the final floor plan against the sunlight heat.
8) To use different materials, bricks, stones, wood and OC/RC, to bridge wall openings using arches and lintels.
9) To manipulate wooden structures to accept plastering.
10) To pipe the bathroom installations.
11) To construct wooden rafted final roofs.
12) To construct domes and vaults by bricks.
13) To plan for a site investigation.
14) To plan for a client meeting.
15) To develop the ability of analyzing data and information.

16) To develop the ability of matching limitations and offerings of a situation against the corresponding available solutions to choose the most suitable one.
17) To develop the ability of future planning.

4-13-3-Appreciation:

1) To appreciate the concept of "*community cooperation*" as a native behavior.
2) To appreciate the concept of "*workers safety comes first*" as a team leader.
3) To appreciating the concept of "*training importance*" as a quality insurance seeker.
4) To appreciating the concept of "*using help to accomplish missions coasts less than doing mistakes*" as a performance developing seeker.
5) To appreciate the concept of "*specialized information importance*" and how it can affect the decisions efficiency.
6) To appreciate the concept of "*matching the surrounding architectural context*".
7) To appreciate the concept of "*The architect's role to lead the community and facilitate its needs*" as a community leader.

The following table shows a comparison between the skills and abilities that have been listed in *Table [6]* with the skills and abilities that are embodied into the game.

4-14-The Framework Validation:

At the end of the thesis, the researcher held interviews with some architectural instructors that used to teach building construction. The chosen instructors either have a long educational experience of building construction or teach the course for a reasonable period beside being well informed about digital technology in general and digital games in particular. The aim of these interviews was to check the validation of the suggested scenarios of the game levels. The questionnaires asked the instructors about their views on the knowledge, skills and abilities supposed to be gained and developed by the end of each level. The results of these questionnaires are presented in appendix 5

Table [8]: A comparison between skills/abilities embodied in the game and the NAAB's & RIBA's ones

		Research Skills	National and Regional Traditions	Structural Systems	Building Envelope Systems	Building Service Systems	Building Systems Integration	Building Materials and Assemblies	Construction Cost Control	Technical Documentation	Architect's Administrative Roles	Architectural Practice	Professional Development	Leadership	Legal Responsibilities
Knowledge	To know the theory and rules of/behind structural issues.			●											
	To know about the site language "jargon"											●			
	To Know about the construction / finishing materials.				●			●							
	To know about the systems and different types of construction.		●	●											
ability	To execute a basic building component (foundation, intermediate slab, roof, etc.)		●	●											
	To check the brick quality							●							
	To protect the building against ground water, rains and sunlight heat.				●			●							
	To pipe the bathroom's installations						●								
	To plan for a site investigation	●									●	●		●	
	To plan for a client meeting	●									●	●		●	●
	To develop the ability of analyzing data & information	●													
	To develop the ability of matching between limitations and offerings of a situation and the corresponding available solutions.										●	●		●	
	To develop the ability of futuristic planning	●									●				
appreciation	To appreciate the concept of "*community cooperation*" as a native behavior										●		●	●	
	To appreciate the concept of "*workers safety comes first*" as a team leader										●	●	●	●	●
	To appreciating the concept of "*training importance*" as a quality insurance seeker												●	●	
	To appreciating the concept of "*using help to accomplish missions coasts less than doing mistakes*" as a performance developer								●						
	To appreciate the concept of "*specialized information importance*" and how can it affect the decisions efficiency						●	●	●	●					
	To appreciate the concept of "*matching the surrounding architectural context*"											●	●		
	To appreciate the concept of "*The architect's role to lead the community and facilitate its needs*"												●	●	

7- Conclusions, Recommendations and Further Studies

Introduction

This research tried to make an academic investigation about the games realm based on the viewpoint of an architectural educator. The research while navigating the two fields of education and gaming tried to focus mainly on what is relevant to its main aim; "To use games for teaching architecture". While exploring what is relevant, some issues have been raised and they need to be investigated in further detailed studies. Some conclusions and recommendations are evolved and are thought to be valuable.

1-Conclusions:

1. The contemporary student generations are different from the past generations. They think in a different way than their predecessors and they search for actions rather than talks. They need to be coached rather than being told information. This differentiation mainly is because of the new life form which surrounds them and they grow within.
2. It is our responsibility, as educators, to match their needs and abilities within the contemporary frame of the educational theories and aims.
3. The previous successful teaching methodologies and techniques should be revised totally to match the new abilities, way of thinking, needs and language of the new and future students.
4. The contemporary digital technology offerings have great potentials, which can greatly develop the educational process.
5. Addressing the full mental abilities of the student's mind enhances his/her ability of knowledge constructing, gaining and retaining.
6. Gaining the student's engagement is the first and most important step towards a successful educational process.
7. Giving the student the freedom to choose his/her own learning passage, as much as it is possible, increases the educational process success probabilities.
8. Games are so powerful that they affect their players greatly. Hence, it is necessary to reconsider the way educators think of that realm. It is necessary to rethink of it seriously enough to use its benefits and avoid its risks.
9. Although using games as educational tools is not the only successful modern educational approach, but it is believed to be the most interesting approach to engage the majority of students.

2-Recommendations:

2-1-General Recommendations:

1. Computer games are very powerful and effective means that affect the players skills, abilities, personality, way of thinking and knowledge content. In some cases, games are the only means through which players see "Others". "Others" here means all what is being ignorant to them such as other cultures, nations and communities. In such cases, if data and information that are impeded into the game are wrong, players will gain wrong information about the "Others". Consequently, it is not enough to have an organization or an institution to just classify games according to its content suitability for different ages. It is recommended to have an authorized accredited organization that has the ability to judge the game content integrity.
2. Both educators and game designers have an essential role in making educational games. Neither of them can replace the other. Hence, in the case of architectural education, it is recommended to search for a joint venture between the architectural schools and the gaming industry to participate in making educational games.
3. Architectural educators should revise and reconstruct the architectural curricula to match the new needs of the contemporary societies.
4. There is no architectural subject that can not be taught by using games. Only, this matter needs the educators to think deeply about how they can manipulate what they are teaching to be in a playable form without giving up the pedagogical aim or gain of the subject.

2-2-Specific Recommendations:

1. Although it is a technical subject, but the building construction curriculum should involve local socio-behavioral issues to assert integration between the technical side and the social side of the architectural work.
2. There is a need to focus on the local building construction methods as they strengthen the relation between the architect and his/her community legacy such as using domes and vaults rather than reinforced concrete.

3-Further Studies:

While conducting this research some other research points popped up. These research points were outside this thesis scope of work while they may be the basis for future research.

3-1-The digital games cultural impact.

While exploring many digital games, the researcher found that many of them have a strong architectural component. For example, the "*Prince of Persia*" game is about an adventure in Old Persia. The game actions happen inside Persian palaces and cities. Hence, the game here is a visual knowledge source about the architecture of Old Persia. How far was the game designer honest while representing this architectural legacy? In addition, how far does an honest architectural representative of a certain historical legacy in such games may harm/help the game?

Moreover, could it be, in some times, made deliberately for a hidden aim? For example, in a racing digital game one of the race courses is in Egypt. The race course was represented in a desert place where sand is every thing and camels are going beside the road. But in case of the American course, it is through very modern city where skyscrapers are in the background and modern cars are driven in the streets. Is it an indirect visual message to be delivered to teenagers?

In other words, how far can games be an architectural visual knowledge source in case of gamers?

3-2-The digital games spread in our local communities.

While searching for the games spread in the world, the researcher found many statistics that measure the games spread in the western societies. This caring is mainly due to the huge gaming industry in the west which involves much more money. On the other hand, there is no accurate statistics to measure the games spread in our local communities. Although gaming is not an industrial concern in our communities but the psychological and social effects of gaming should draw our attention regarding having accurate statistics about the games spread in our communities.

3-3-The essential component categories that represent a community character.

While searching into the games abilities to be used to teach the "Knowing Why" issues in chapter five, a framework was suggested. One of the components of this framework was a knowledge base plug-in. This plug-in is supposed to be a pluggable patch, which contains facts and rules of a certain community. The role of this plug-in is to control the virtual client's reactions towards the player's actions and design decisions. The purpose of this control mechanism is to make these reactions more human and representative of the local community of the virtual client such as rural

community, Nubian community, and others. If we think of this plug-in as a tree of data, we will find two main issues that still need to be investigated:

1. The first issue is the tree branches. What are the categories of such data? For example, these data may have two main categories; general humane characteristics and special community characteristics. The first category is what makes the client have a normal humane reaction. The second category is what makes the client belong to a certain community. The second category, for example, may be classified to physical characteristics and behavioral characteristics and both of them may be classified into other classes, and so on.
2. The second issue is the interactions between the tree branches. How the characteristics of each category interact with, affect and are affected by the other characteristics in the same category or other categories.

The aim of such plug-in should not be a quantitative product. It should not aim at a numerical model of the human behavior because it is impossible to predict the exact behavior of any human figure. Rather, the aim should be a qualitative matrix of the human behavior. For example, the product should not concern how far the rural client would be interested in the dynamic open architectural spaces. Rather, it should concern the rural client preferences of the dynamic open architectural spaces rather than the definite static architectural spaces.

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Appendices

Appendix 1: NAAB Conditions for Accreditation; skills and abilities

Skill/ability	Description	accomplishment level
1. Speaking and Writing Skills	Ability to read, write, listen, and speak effectively	A
2. Critical Thinking Skills	Ability to raise clear and precise questions, use abstract ideas to interpret information, consider diverse points of view, reach well-reasoned conclusions, and test them against relevant criteria and standards	A
3. Graphics Skills	Ability to use appropriate representational media, including freehand drawing and computer technology, to convey essential formal elements at each stage of the programming and design process	A
4. Research Skills	Ability to gather, assess, record, and apply relevant information in architectural coursework.	A
5. Formal Ordering Systems	Understanding of the fundamentals of visual perception and the principles and systems of order that inform two- and three-dimensional design, architectural composition, and urban design	U
6. Fundamental Design Skills	Ability to use basic architectural principles in the design of buildings, interior spaces, and sites	A
7. Collaborative Skills	Ability to recognize the varied talent found in interdisciplinary design project teams in professional practice and work in collaboration with other students as members of a design team	A
8. Western Traditions	Understanding of the Western architectural canons and traditions in architecture, landscape and urban design, as well as the climatic, technological, socioeconomic, and other cultural factors that have shaped and sustained them	U
9. Non-Western Traditions	Understanding of parallel and divergent canons and traditions of architecture and urban design in the non-Western world	U
10. National and Regional Traditions	Understanding of national traditions and the local regional heritage in architecture, landscape design and urban design, including the vernacular tradition	U
11. Use of Precedents	Ability to incorporate relevant precedents into architecture and urban design projects	A
12. Human Behavior	Understanding of the theories and methods of inquiry that seek to clarify the relationship between human behavior and the physical environment	U
13. Human Diversity	Understanding of the diverse needs, values, behavioral norms, physical ability, and social and spatial patterns that characterize different cultures and individuals and the implication of this diversity for the societal roles and responsibilities of architects	U

14. Accessibility	Ability to design both site and building to accommodate individuals with varying physical abilities	A
15. Sustainable Design	Understanding of the principles of sustainability in making architecture and urban design decisions that conserve natural and built resources, including culturally important buildings and sites, and in the creation of healthful buildings and communities	U
16. Program Preparation	Ability to prepare a comprehensive program for an architectural project, including assessment of client and user needs, a critical review of appropriate precedents, an inventory of space and equipment requirements, an analysis of site conditions, a review of the relevant laws and standards and assessment of their implication for the project, and a definition of site selection and design assessment criteria	A
17. Site Conditions	Ability to respond to natural and built site characteristics in the development of a program and the design of a project	A
18. Structural Systems	Understanding of principles of structural behavior in withstanding gravity and lateral forces and the evolution, range, and appropriate application of contemporary structural systems	U
19. Environmental Systems	Understanding of the basic principles and appropriate application and performance of environmental systems, including acoustical, lighting, and climate modification systems, and energy use, integrated with the building envelope	U
20. Life Safety	Understanding of the basic principles of life-safety systems with an emphasis on egress	U
21. Building Envelope Systems	Understanding of the basic principles and appropriate application and performance of building envelope materials and assemblies	U
22. Building Service Systems	Understanding of the basic principles and appropriate application and performance of plumbing, electrical, vertical transportation, communication, security, and fire protection systems	U
23. Building Systems Integration	Ability to assess, select, and conceptually integrate structural systems, building envelope systems, environmental systems, life-safety systems, and building service systems into building design	A
24. Building Materials and Assemblies	Understanding of the basic principles and appropriate application and performance of construction materials, products, components, and assemblies, including their environmental impact and reuse	U
25. Construction Cost Control	Understanding of the fundamentals of building cost, life-cycle cost, and construction estimating	U
26. Technical Documentation	Ability to make technically precise drawings and write outline specifications for a proposed design	A

27. Client Role in Architecture	Understanding of the responsibility of the architect to elicit, understand, and resolve the needs of the client, owner, and user	U
28. Comprehensive Design	Ability to produce a comprehensive architectural project based on a building program and site that includes development of programmed spaces demonstrating an understanding of structural and environmental systems, building envelope systems, life-safety provisions, wall sections and building assemblies and the principles of sustainability	A
29. Architect's Administrative Roles	Understanding of obtaining commissions and negotiating contracts, managing personnel and selecting consultants, recommending project delivery methods, and forms of service contracts	U
30. Architectural Practice	Understanding of the basic principles and legal aspects of practice organization, financial management, business planning, time and project management, risk mitigation, and mediation and arbitration as well as an understanding of trends that affect practice, such as globalization, outsourcing, project delivery, expanding practice settings, diversity, and others	U
31. Professional Development	Understanding of the role of internship in obtaining licensure and registration and the mutual rights and responsibilities of interns and employers	U
32. Leadership	Understanding of the need for architects to provide leadership in the building design and construction process and on issues of growth, development, and aesthetics in their communities	U
33. Legal Responsibilities	Understanding of the architect's responsibility as determined by registration law, building codes and regulations, professional service contracts, zoning and subdivision ordinances, environmental regulation, historic preservation laws, and accessibility laws	U
34. Ethics and Professional Judgment	Understanding of the ethical issues involved in the formation of professional judgment in architectural design and practice.	U

Appendix 2: RIBA Criteria for Validation

Criteria for Validation: Part 1

PART 1: DESIGN

students will demonstrate coherent architectural designs that:

- **integrate a knowledge of:**
  - The ways that analysis, research, context, budget, preparation and development of a brief inform a design proposal
  - The regulatory frameworks, and health & safety considerations that guide design and building construction
  - Architectural histories and theories, of physical, artistic and cultural contexts, and their use in informing the design process
- **And ability to:**
  - Work as part of a team

PART 1: TECHNOLOGY & ENVIRONMENT

students will demonstrate, within coherent architectural designs and academic portfolio

- **The ability to integrate knowledge of:**
  - The principles of building technologies, environmental design and construction methods, in relation to: human well-being, the welfare of future generations, the natural world, consideration of a sustainable environment, use of materials, process of assembly and structural principles.
  - The impact on design of legislation, codes of practice and health and safety both during the construction and occupation of a project

PART 1: CULTURAL CONTEXT

Students will demonstrate within coherent architectural designs and academic portfolio:

- **Awareness of:**
  - The influences on the contemporary built environment of individual buildings, the design of cities, past and present societies and wider global issues.
- **Knowledge of:**

- The histories and theories of architecture and urban design, the history of ideas, and the related disciplines of art, cultural studies and landscape studies.

- **And ability to:**
  - Form considered judgments about the spatial, aesthetic, technical and social qualities of a design within the scope and scale of a wider environment.
  - Reflect upon, and relate their ideas to, a design and to the work of others.

PART 1: COMMUNICATION

Students will demonstrate within coherent architectural designs and academic portfolio

- **Ability to:**
  - Use visual, verbal and written communication methods and appropriate media (including sketching, modeling, digital and electronic techniques) to clearly and effectively convey and critically appraise design ideas and proposals
  - Use the conventions of architectural representation from two-dimensional and three-dimensional graphics to computer generated and physical models
  - Listen, and critically respond to, the views of others.

PART 1: MANAGEMENT PRACTICE & LAW

Students will demonstrate within an academic portfolio

- **An awareness of:**
  - The principles of business management and how a small business operates
- **Knowledge of:**
  - How buildings are designed and built in the context of architectural and professional practice and the framework of the construction industry within which it operates
- **And ability to:**
  - Manage and appraise their own working practices, whether working independently or collaboratively.

Criteria for Validation: Part 2

PART 2: DESIGN

Students will produce and demonstrate coherent and well resolved architectural designs that

- **Integrate knowledge of:**
  - The social, political, economic and professional context that guides building construction
- **An understanding of:**
  - Briefs and how to critically appraise them to ensure that the design response is appropriate to site and context, and for reasons such as sustainability and budget
  - The regulatory requirements, including the needs of the disabled, health and safety legislation and building regulations and development control, that guide building construction
  - An appropriate philosophical approach which reveals an understanding of theory in a cultural context
- **And ability to:**
  - Generate and systematically test, analyze and appraise design options, and draw conclusions which display methodological and theoretical rigour
  - Work as part of a team

PART 2: TECHNOLOGY & ENVIRONMENT

Students will demonstrate, within coherent architectural designs and academic portfolio:

- **The ability to integrate knowledge of:**
  - The principles and theories associated with visual, thermal and acoustic environments
  - Climatic design and the relationship between climate, built form, construction, life style, energy consumption and human well-being
- **Understanding of:**
  - Building technologies, environmental design and construction methods in relation to: - human well-being - the welfare of future generations - the natural world - the consideration of a sustainable environment
  - The impact on design of legislation, codes of practice and health and safety both during the construction and occupation of a project
- **And ability to:**

- Devise structural and constructional strategies for a complex building or group of buildings, employing integrative knowledge of; - structural theories - construction techniques and processes - the physical properties and characteristics of building materials and components and the environmental impact of specification choices - the provision of building services

PART 2: CULTURAL CONTEXT

Students will demonstrate within coherent architectural designs and academic portfolio

- **Understanding of:**
  - The influences on the contemporary built environment of individual buildings, the design of cities, past and present societies and wider global issues
  - The histories and theories of architecture and urban design, the history of ideas, and the related disciplines of art, cultural studies and landscape studies and its application in critical debate
  - The inter relationship between people, buildings and the environment and an understanding of the need to relate buildings and the spaces between them to human needs and scale
- **And ability to:**
  - Critically appraise and form considered judgments about the spatial, aesthetic, technical and social qualities of a design within the scope and scale of a wider environment
  - Independently define, and critically appraise, their ideas in relation to a design and to the work of others

PART 2: COMMUNICATION

Students will demonstrate within coherent architectural designs and academic portfolio

- **Understanding of:**
  - The contribution of other professionals in the design process showing an appropriate use of team working skills, recognizing the importance of current methods in the construction industry
- **And ability to:**

- Use visual, verbal and written communication methods and appropriate media (including sketching, modeling, digital and electronic techniques) to represent the testing, analysis and critical appraisal of complex design proposals and their resolution to a range of professionals and lay audiences
- Use architectural representations having critically appraised the most appropriate techniques available
- Produce documentation and reports which are clear, analytical and logical covering a range of architectural issues of culture, theory and design

PART 2: MANAGEMENT PRACTICE & LAW

Students will demonstrate within an academic portfolio

- **Knowledge of:**
  - How cost control mechanisms operate within the development of an architectural project
- **Understanding of:**
  - The basic principles of business management and factors related to running a design practice and how architects organize, administer and manage an architectural project, recognizing current and emerging trends in the construction industry such as partnering, integrated project process, value engineering and risk management
  - The inter-relationships of individuals and organizations involved in the procurement and delivery of architectural projects, and how these are defined and effected through a variety of contractual and organizational structures
  - The fundamental legal, professional and statutory requirements as they are relevant to building design and practice, with particular reference to matters relating to health & safety and universal design for access.
  - The professional duties and responsibilities of architects, as defined and described in the Codes and Standards relating to their professional practice

- **And ability to:**
  - Identify and manage individual learning needs so as to prepare for and maintain professional standards commensurate with qualification

Criteria for Validation: Part 3

At Part 3 students will demonstrate within an academic portfolio:

THE CONTEXT FOR PRACTICE

- **Knowledge of:**
  - The size and relative importance of the construction industry to other sectors of the national and international economy and the role of the profession relative to the industry
  - The overlapping interests of organizations representing the built environment and their relation to the role of the architect
  - The range of ongoing specialist panels of advisory, consultative or government bodies which have the responsibility for developing policies which guide or control construction industry practices
- **Understanding of:**
  - The social and economic context for investment in the built environment
- **Ability to:**
  - Apply principles underlying the law relevant to architectural practice and building procurement
  - Act in accordance with the requirements of professional conduct and the concept of 'professionalism'
  - Follow codes and standards regulating the profession of architecture
  - Demonstrate that health and safety matters are integral to every stage of the design process and execution for those aspects of design for which the architect is responsible

THE MANAGEMENT OF ARCHITECTURE

- **Awareness of:**
  - Technical standards and sources of specialist information
- **Knowledge of:**
  - Legislation on health and safety and its application to design and construction

- **Understanding of:**
  - Appropriate fees, negotiation and fee bidding techniques, bearing in mind the funding and procurement basis for the project, and with reference to other factors listed below
  - Integrated project process and project team partnering
  - Relevant statutory bodies, construction and development legislation and consultative bodies, and their potential effect on programme, cost and quality of design
  - Methods and standards intended to ensure and manage quality standards
- **Ability to:**
  - Prepare, in consultation with the client, an acceptable brief and budget, including consultation with others as appropriate. Thereafter, to effectively communicate with the client at every stage of the project
  - Assess the variety and appropriateness of project procurement methods and their implications in relation to client requirements and the architectural and professional input required
  - Assess the architectural services required to deliver a project effectively and the establishment of appropriate scope of works for all members of the project team; to co-ordinate and integrate the work of other consultants and an awareness of the terms of their appointments
  - Programme and manage the flow of information among the members of the design team
  - Communicate effectively with each part of the client body and construction team
  - Operate quality assurance procedures which ensure the maintenance of design standards and intentions in relation to budgetary and programme control
  - Analyse the appropriateness and completeness for its purpose of forms of documentation including written and graphic communication

THE MANAGEMENT OF CONSTRUCTION

- **Knowledge of:**
  - Site organisation, mobilisation and the establishment of appropriate lines of communication in relation to the specific responsibilities of the building team

- Methods of dispute resolution, conciliation, adjudication, arbitration, and litigation

- **Understanding of:**
  - Project planning, documentation and execution
  - The range of methods of building procurement, tender types and codes of practice for procedure, and an ability to identify an appropriate contract strategy and to create pre-contract information
  - Value engineering, integrated supply chain management and the principles of lean construction
  - The implications of, and ability to apply, collateral agreements such as the nomination of sub contractors and the position of domestic sub contractors, suppliers, manufacturers and statutory undertakings in relation to standard forms of contract
  - Risk management in relation to construction and consultants contracts, liabilities, indemnities and insurance and awareness of mechanisms such as insurance to deal with liabilities
  - The value of post completion assessment and appraisal and methods of de-briefing
  - The maintenance of adequate financial control for cost planning of projects

- **Ability to:**
  - Analyse contract types in terms of their implications for time, cost, quality, information flow and the procedures related to each
  - Assess and organise a quality control and programming system in relation to the architect's role in administering the building process
  - Prepare architect's instructions and certificates appropriately for standard forms of contract, and to implement the procedures for the assessment and valuation of claims
  - Create maintenance manuals and post completion information for clients and building users

PRACTICE MANAGEMENT AND BUSINESS ADMINISTRATION

- **Awareness of:**
  - The need and techniques for the protection of intellectual property and copyright

- The various techniques for the marketing of professional services and how architects commissions are obtained
- National and international trends for the distribution and commissioning of architectural projects

- **Knowledge of:**
  - The requirements for taxation, health and safety, employment contracts, civil liability, and equal opportunities legislation, etc. on different business structures, including working from home
- **Understanding of:**
  - The resources (technical, IT, financial, personnel, etc.) necessary in order to offer professional services for a particular project
  - Different forms of architectural practice, for example, sole trader, partnership, company, consortium or joint venture, and their respective legal implications
  - The internal structures and organisations appropriate to different forms of architectural and multi-disciplinary practice • The skills required for the management of people within an organisation and a basic appreciation of motivation, group dynamics, staff appraisal and reward structures
  - The techniques and context required to create an effective and efficient ongoing environment for practice
  - The financial management of an architectural practice

Appendix 3: A summary of some building construction related courses in some different architectural schools and universities.

1. Ain Shams University, Egypt

ARC 110 CH BUILDING CONSTRUCTION The course introduces students to basic components of buildings - building materials and types of finishes. Exercises to train students to comprehend architectural drawings and the notions used. The course includes load-bearing constructions of brick and stone - Lintels -Arches - Vaults - Domes - Thermal insulation - Water proofing - Staircases in buildings (Types - Materials and design considerations) - Architectural finishing for floors - Walls and ceilings - Joints in buildings and architectural treatments.

ARC 111 CF BUILDING CONSTRUCTION (1) Introductory course to basic components of buildings - Building materials and methods of construction (load-bearing and skeleton types) -Exercises to train students in detailed drawings of: load-bearing constructions of brick and stone - lintels Arches Vaults - Domes -Foundations - Skeletal construction of concrete and timber - Retaining walls (Masonry - Concrete) - Thermal insulation and water proofing - stairs (Concrete - Timber - Steel).

2. Cairo University, Egypt

ARC 105 Building Construction (2+1) Objective: To introduce, both theoretically and practically, the study to the basics of building construction and building materials. Contents : The representation of various materials in Architectural and structural documents. - Principles of Building with various materials; Stone, Wood, Brick, Concrete, Steel - Building Types; skeleton & wall bearing - Arches, lintels & stairs. - Insulation; Water, Sound and Heat. - Introduction to finishing materials.

3. Columbus State Community College, USA

ARCH 155 Residential Construction/Wood Structures 3 credits(A, SP) This course outlines the various phases of residential construction for site analysis to finish material installations, including conventional wood framing, floor and roof truss framing, heavy timber/post and beam construction, and various plywood panel construction techniques. Additional topics discussed include the design and use of floor joist span charts, simple beam and footing design, as well as roof and foundation design. This course concludes with the choice of building a structural/framing model or preparing a power point presentation of a residential construction task. Lecture: 1 hour - Lab: 5 hours Prerequisite: CIVL 120 Corequisite: Lab fee: $12.00

ARCH 232 Building Construction Standards 3 credits(A, SP) This course focuses primarily on building and zoning codes. Emphasis is placed on the OBBC (Ohio Basic Building Code) and the Columbus, Ohio zoning code. Other areas of study include: the influence of professional associations, manufacturers, and testing laboratories in design and construction documents; CSI specifications, their organization, content and relationship to other contract documents; and professional practice in architecture. Lecture: 1 hour - Lab: 5 hours Prerequisite: CMGT 121 Corequisite: Lab fee: $12.00

ARCH 237 Structures-Steel, Concrete and Masonry 4 credits(W, SU) This course presents basic conceptual and practical structural design concepts. Steel, concrete and masonry structures are studied and evaluated mathematically. The student will learn how to evaluate and design beams and columns in both steel and concrete. Other topics include

bearing plate/base plate design, bolted and welded connections, concrete and masonry wall design. Drafting projects require the use of CAD and will focus on structural elements. Lecture: 2 hours - Lab: 6 hours Prerequisite: MATH 148, ARCH 114 and MECH242 Corequisite: Lab fee: $12.00

ARCH 250 Building Enclosure Materials 3 credits(A,SP) This course is designed to expand on the knowledge gained in CIVL 120, with the study of how such materials and others are combined to form the building shell. The courses focuses on the separation between exterior and interior environments. Topics covered include roofing, glass, windows and doors, walls, foundations, and interior finishes, vertical transportation and acoustics. Lecture: 2 hours - Lab: 3 hours Prerequisite: CIVL 120 Corequisite: Lab fee: $12.00

4. Texas Tech Uni, USA

2351. [ARCH 2312] Architectural Construction I (3:3:0). Introduction to construction systems, methods, and materials with emphasis on the wall section. Introduction to issues of sustainability and envelope performance.

5. A. Alfred Taubman College of Architecture, The University of Michigan, USA

Arch 317 Construction I (3 credit hours).This course offers an introduction to the study of construction materials and methods. The course stresses general principles that affect construction and its relationship to design intentions. It is divided into three sections: masonry, light frame, and enclosure. Specific topics within these sections include unit modularity, wall systems, floor and roof systems, waterproofing, prefabrication, and project delivery. Exercises that provide a focus for discussion and practice relating to the broader issues of the course center on masonry and light wood frame

6. City College of San Francisco, USA

ARCH 23. Materials and Methods of Construction. A survey of development, use, and application of building materials; the ways in which they satisfy utilitarian needs and provide visual satisfaction. CSU

ARCH 50. Construction Drawings. Study of construction documents with an emphasis on light wood frame construction and ecological sustainability. Building and framing systems, detailing, site issues, codes and regulations, research and professional publications in architecture and construction disciplines through creation of a simple set of construction documents. CSU

7. The Pennsylvania State University, USA

Architecture 203 - Materials and Building Construction I Instruction in the design and construction of buildings utilizing wood and steel. Prerequisite: third-semester standing in the architecture curriculum

Architecture 204 - Materials and Building Construction II This course will continue the presentations of Arch 203, with a focus on concrete and masonry materials. Prerequisite: Arch 203, fourth semester standing in the Architecture curriculum

8. Harold Washington College, USA

Architecture 150 Construction Cost Estimating - Elementary course in construction cost estimating, taking account of technological advancements and constant introduction of new

materials and methods of construction; comparative analysis of building methods and materials, quantity take-off techniques. Writing assignments, as appropriate to the discipline, are part of the course. Prerequisite: Architecture 115 or consent of department chairperson. 150 minutes per week. 3 credit hours.

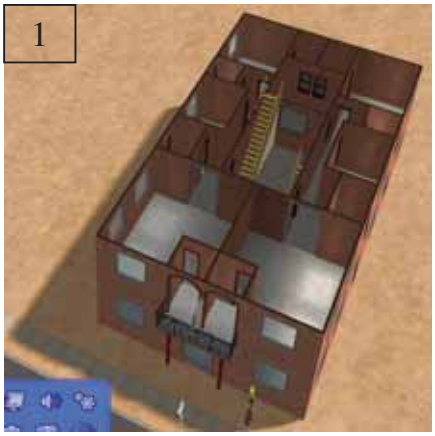
Architecture 202 General Construction - Study of materials used in building construction, their growth or manufacture, preparation and application; emphasis on frame and masonry construction types; working drawings and structural details. Writing assignments, as appropriate to the discipline, are part of the course. Prerequisite: Architecture 171 and Mechanical Technology 171, or consent of department chairperson. 2 lecture hours and 4 lab hours per week. 4 credit hours.

Architecture 204 General Construction, Advanced - Continuation of Architecture 202. Emphasis on advanced structural detailing and working drawings. Writing assignments, as appropriate to the discipline, are part of the course. Prerequisite: Architecture 202 or consent of department chairperson. 2 lecture hours and 4 lab hours per week. 4 credit hours.

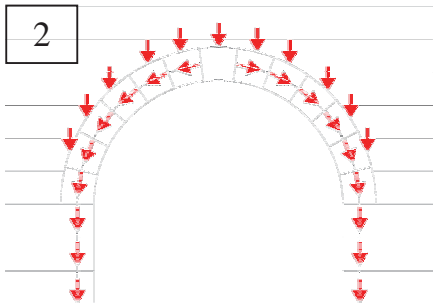
9. University of Texas at Austin, USA

ARC 415: CONSTRUCTION I. OBJECTIVES: This course is the first of five in the construction sequence. It is intended to be an introduction to the production, assemblage, and performance of structural, envelope, and finish materials. Basic ideas of statics, solid mechanics, and systems integration will serve as constant theme in the discussion of each material. Readings, lectures, discussions, projects, and field trips will investigate each material in the context of historical and cultural evolution, system performance, and architectural invention and technology. We will begin to define performance criteria that will serve as a point of departure from which we can innovate and invent in the context of contemporary issues.

Appendix 4: Graphical presentation of the "Antimonopoly" level.

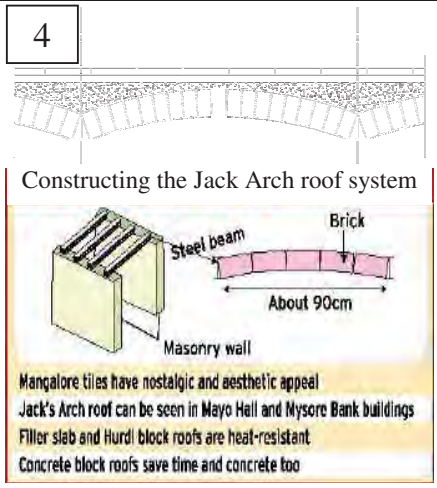


The start point of the level, a two-story building; its walls were built but the roof slab is not yet built.



When the player asks for help, *A'am Fathi* tells *Ali* a story. In his story, he embodies hints and clues about the theory behind using curved surfaces to transfer loads to side supports. This help would be classified as a primitive help

If the player failed to find the proper solution by the primitive help, he may ask *A'am Fathi* for intermediate help which consumes more points. In this case *A'am Fathi* tells *Ali* another story about how curved surfaces are being used as bridges.

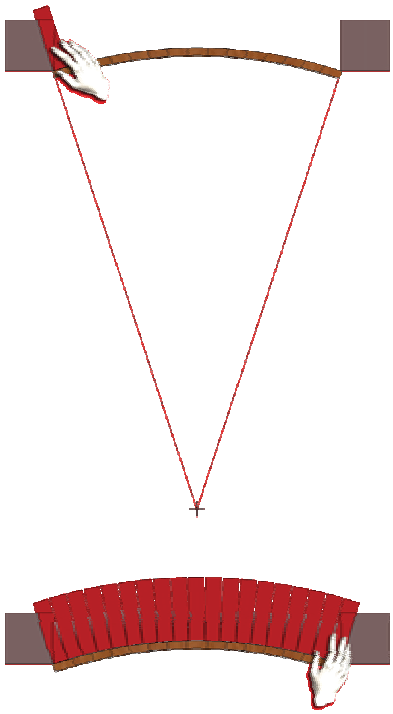


If the player totally failed to find the proper solution even by the intermediate help, he may ask *A'am Fathi* for a determinate solution which consumes much more points of the player's credit. In this case *A'am Fathi* tells *Ali* about the Jack Arch system and how it has been used to cover spaces in replace of the RC slabs, domes or vaults.

5

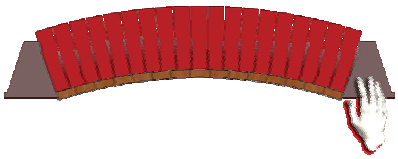
After finding the proper solution, the player starts to compose a sketch of it. He chooses the optimum span that consumes the least height and the least amount of steel rods in the same time.

6

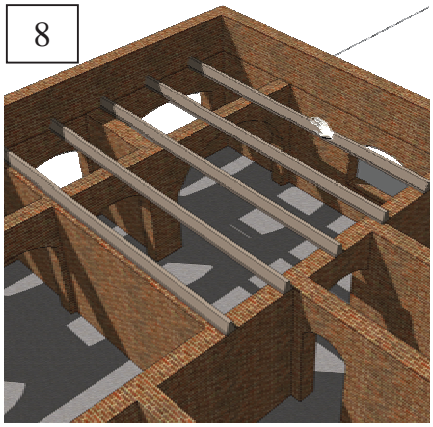
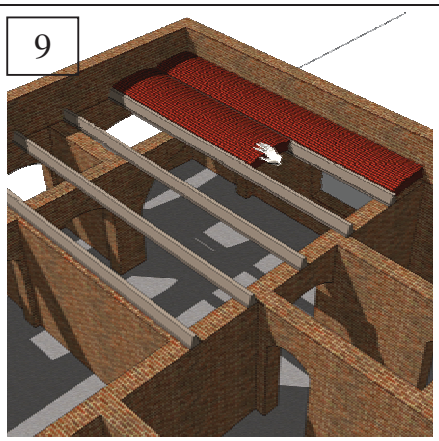
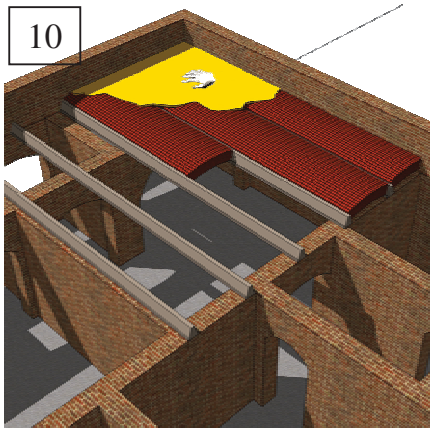
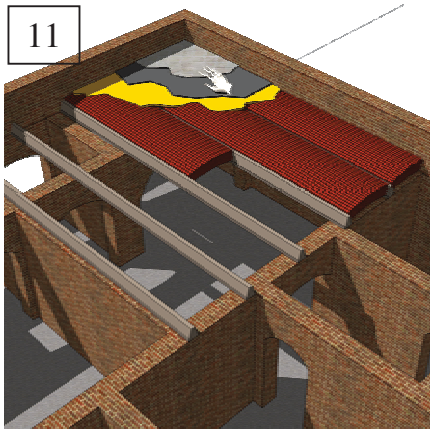


After determining the proper span, the player starts to arrange bricks to form the shallow vaults

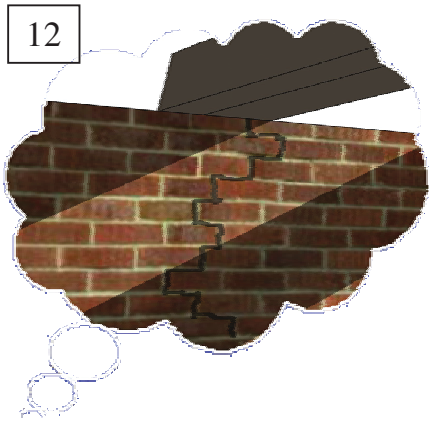
7



Finally, the player reshapes the side supports to suit the brick arrangement.

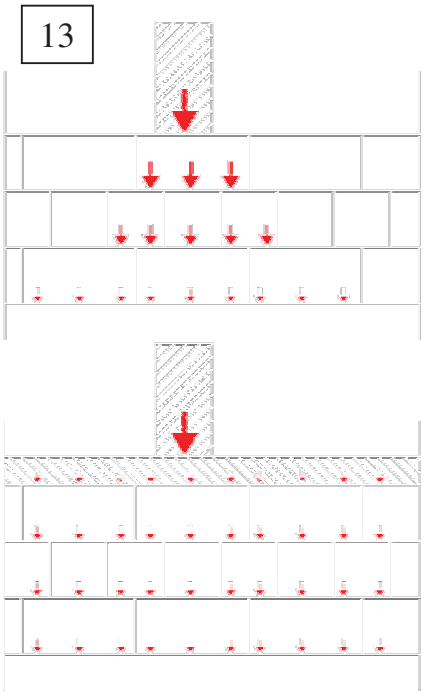
8  After *Ali* finishes composing the sketch of his proper solution, he starts to execute his solution in the 3D environment. He arranges the RC beams.	9  Then, he starts to form the shallow vaults.
10  After that, he adds the sand layer to flatten the upper surface.	11  Then he adds mortar and the finishing tiles. By doing so, he finishes executing his solution. Therefore, he asks the *Boss* to check his solution's validity.

12



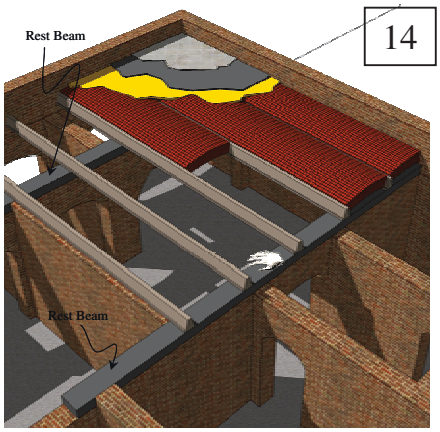
When the *Boss* checks *Ali's* solution, a callout pops out from his head showing the solution implications. The callout here represents some cracks that appeared below the beams

13



When Ali asks *A'am Fathi* to explain what happened, he tells him a story. In his story he embodies hints and clues about the concept of distributing loads by rest beams.

14



Because of this help, *Ali* should add rest beams below the other beams to distribute the transferred concentrated loads.

When Ali finishes solving the construction problem successfully, a documentary film is offered. The film shows a real construction site with the same construction problem he was experiencing. The same film is also demonstrated in case of the player's total failure to teach him the solution.

Appendix 5: The Validation Questionnaire

Dear Sir:

It honors me to ask you for your opinion about the end product of my Ph.D. thesis. The thesis investigates the ability of using the digital games as educational tools for teaching architecture. The thesis chose the "Building Construction I" course as a study case to draw out a theoretical framework for a digital game that can be used as an educational tool while teaching the course. Because of your long valuable experience as an educator and instructor of such a course, your opinion about the proposed framework of the game is mostly appreciated.

This document tries to explain the main idea of the game and then illustrates just five levels of the 19 levels of the game. After each level you are required to input your opinion about the validity of the suggested knowledge, skills and ability which will be transferred and developed by the end of the level. You are supposed to choose between three choices that are; "YES", "NO" or "Don't KNOW". The choice should be based on your belief about the level's success to transfer the addressed knowledge and to develop the addressed skill or ability. I really thank you for your valuable time, effort and contribution.

Introduction:

"The Builder" is a third person adventure-like game. The game tries to involve the player into a pre-designed set of site situations through which he/she would gain the basic knowledge, skills and abilities of small simple buildings construction. The game manipulates the basic site situations to be in the form of riddles and puzzles which the player goes through as in adventure games.

Narrative Summary

"Ali" is a young man who lives in an imaginary native community where the rules of the guild system are still governing. He dreams about being a "Master Builder" but according to the governing rules he should be accredited by the builders guild governor. To achieve this accreditation he should go through a long way of practice just to be called a "builder" which is the first step of his "Master Builder" career dream.

Characters of The game

- *Ali*" is the main character of the game who is controlled by the player. The name is derived from the slogan "pl**A**y to **L**earn arch**I**tecture".

- *A'AM Fathy* is the help avatar of the game. *A'AM Fathy* never tells direct directions or solutions. He embodies clues and hints within historical stories.
- "*The boss*" is the regulator avatar who provides a brief to the in-hand problem to explain its narrative context, limitations, rules and aim. It also judges *Ali's* performance.

Playing the Game

Playing as *Ali*, the player explores many construction issues that cover different critical construction phases, goes through helping tutorials and educational videos that explain and help the player to solve some construction problems.

At the construction site, when *Ali* is asked to perform a job he has to choose between starting immediately or asking for help. In the second case, he asks the help avatar, *A'AM Fathy*, who starts to tell him a story about the problem in-hand and embeds some hints and clues into this story. After the completion of each challenge, player is offered the chance to watch a short movie that explains some further facts and information about the completed challenge.

The Game Scenario

In the beginning of the game *the Boss* asks *Ali* to choose a construction problem to start with. Hence, *the Boss* declares the problem's narrative and physical context which contains the problem's offerings, limitations, guiding rules, data and facts. After that, *Ali* starts to use a set of tools to solve the construction problem. When he finishes his solution, he asks *the Boss* to check it. *The boss* checks *Ali's* solution and if it has no faults he declares his success. Else, a callout pops up from the *bosss* head showing a foreseeing representation about *Ali's* solution implications. In case of his failure, *Ali* should observe and analyze his solution's implications and choose either to fix his solution or to experience another modified version of the same problem, and the cycle goes on.

The game levels:

The game consists of 19 levels and the coming section will only represent five levels of them.

Issue one: "Help workmate to build his own house".

The level's construction problem:

To lay the foundations of a bearing wall building constructed of brick/stones.

The level's physical context:

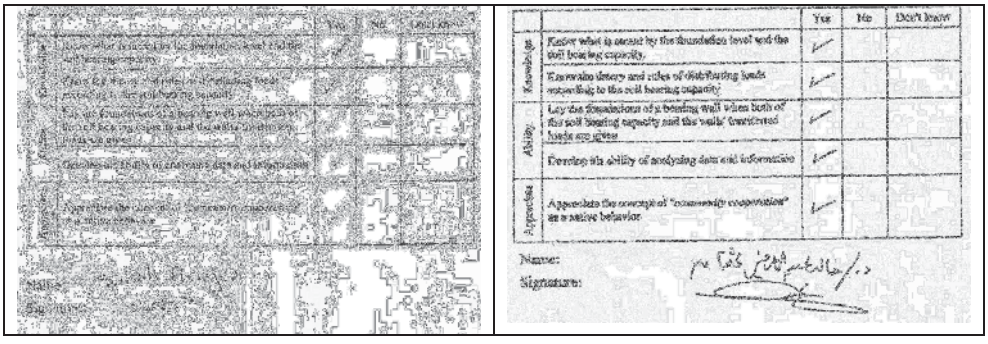
The site is already excavated. The building is a one story building and the ground floor is 30 cm above zero. No basement is required. The building location is nearby a cultivated land. Bricks will be the construction material. Soil bearing capacity and the wall's transferred loads will be given.

The game:

In this level *Ali's* workmate is going to marry. As it is a social habit, the bridegroom's workmates would help him to build his new home. As a community member, *Ali* should participate. *Ali* is supposed to participate in laying the foundations of a bearing wall.

If *Ali* started immediately without knowing about the soil bearing capacity and the transferred loads through the wall he may experience the problem of a "*Wall Settlement*". In this case he may ask *A'AM Fathy* for help. If so, *A'AM Fathy* tells *Ali* about the concept of the soil bearing capacity and why camels do not experience problems while walking on sand and also how we can establish a heavy table with thin legs on the sand. Hence, *Ali* is supposed to analyze what *A'AM Fathy* told him to search for the right solution. If *Ali* totally failed to solve the situation, *A'AM Fathy* offers a full explanation and a documentary film about how to lay the foundation of a bearing wall.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



Issue two: "Boss asks for a wooden shelter".

The level's construction problem:

To lay the foundations of a skeleton building constructed of wood

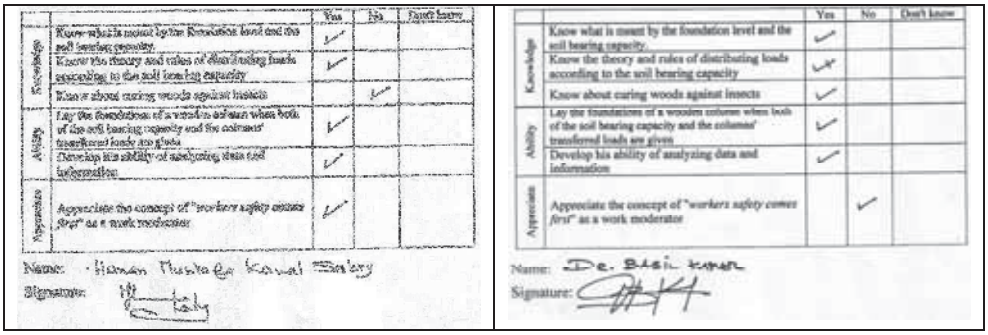
The level's physical context:

The site is already excavated. The building is a one story building and the ground floor is 30 cm above zero. No basement is required. The building location is in the desert. Wood will be the construction material. Soil bearing capacity and the column's transferred loads will be given.

The game:

"*We are moving to a new construction site location*." Boss said. "*The place is so hot and windy and we will stay there for about two months. So the first thing we will build is a wooden shelter to accommodate us. Ali, you are assigned to lay the foundations*." If *Ali* started immediately without knowing about the soil bearing capacity and the transferred loads through the wooden columns he may experience the problem of a "*Column Settlement*". In this case he may ask *A'AM Fathy* for help. If so, *A'AM Fathy* tells *Ali* about the concept of the soil bearing capacity and why camels do not experience problems while walking on sand and also how we can establish a heavy table with thin legs on the sand. Hence, *Ali* is supposed to analyze what *A'AM Fathy* told him to search for the right solution. In addition, *A'AM Fathy* would tell *Ali* about the necessity of protecting wood against insects. Moreover, *Ali* should take into consideration how to fasten and connect a wooden column to a RC base. If *Ali* totally failed to solve the situation, A'AM Fathy offers a full explanation and a documentary film about how to lay the foundation of a wooden column.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



		Yes	No	Don't know
Knowledge	Know what is meant by the foundation level and the soil bearing capacity.	✓		
	Know the theory and rules of distributing loads according to the soil bearing capacity	✓		
	Know about curing woods against insects		✓	
Ability	Lay the foundations of a wooden column when both of the soil bearing capacity and the columns' transferred loads are given	✓		
	Develop his ability of analyzing data and information	✓		
Appreciate	Appreciate the concept of "*workers safety comes first*" as a work moderator	✓		

Name: Hanan Mostafa Kamal Shehy
Signature:

		Yes	No	Don't know
Knowledge	Know what is meant by the foundation level and the soil bearing capacity.	✓		
	Know the theory and rules of distributing loads according to the soil bearing capacity	✓		
	Know about curing woods against insects	✓		
Ability	Lay the foundations of a wooden column when both of the soil bearing capacity and the columns' transferred loads are given	✓		
	Develop his ability of analyzing data and information	✓		
Appreciate	Appreciate the concept of "*workers safety comes first*" as a work moderator		✓	

Name: De. Basil Kamel
Signature:

Issue three: "Building the village's school".

The level's construction problem:

To lay the foundations of a skeleton building constructed of OC/RC.

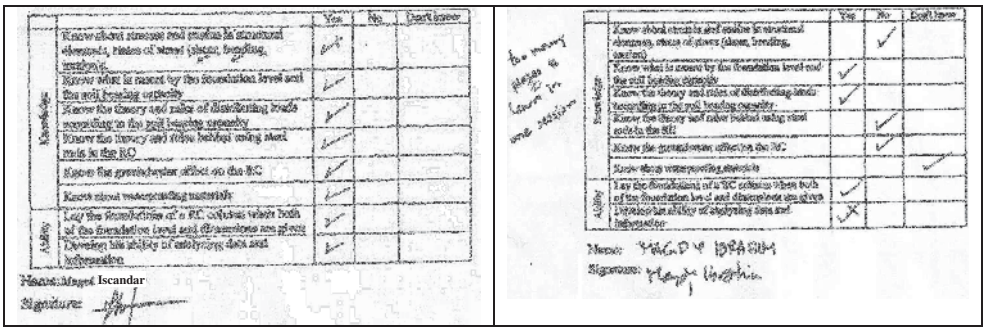
The level's physical context:

The site is already excavated. The building is a multi story building and the ground floor is 120 cm above zero. A basement is required. The building location is nearby a cultivated land. The building will be a RC skeleton building with bricks as a filling material. The groundwater table level will be given.

The Game:

"*Ok, as you know boys our village needs a school*" said *the Boss*. "*Our beloved mayor will construct one for us and he hired us to help. Let us do it*". *Ali* should participate in laying the foundation of the building. If he started immediately without knowing about the soil bearing capacity and the transferred loads through the RC columns he may experience the problem of a "*Column Settlement*". In this case he may ask *A'AM Fathy* for help. If so, *A'AM Fathy* tells *Ali* about the concept of the soil bearing capacity and why camels do not experience problems while walking on sand and also how we can establish a heavy table with thin legs on the sand. Hence, *Ali* is supposed to analyze what *A'AM Fathy* told him to search for the right solution. In addition, *A'AM Fathy* would tell *Ali* about the effect of the ground water on the steel rods and how rust causes steel rods to lose their ability to resist tension forces. Moreover, if Ali forgot to tie columns with underground RC beams, he may experience a collapse of the system because of the lateral forces. If Ali asked *A'AM Fathy* for help, he would tell him a story about the skeleton system and how it depends on vertical and horizontal structural elements to transfer loads and to work together as a single unit.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



Issue four: "Training field"

The level's construction problem:

To use bricks to build bearing walls using the Flemish bond and the English bond orders. Moreover player will use stones to build walls using many stone bonds.

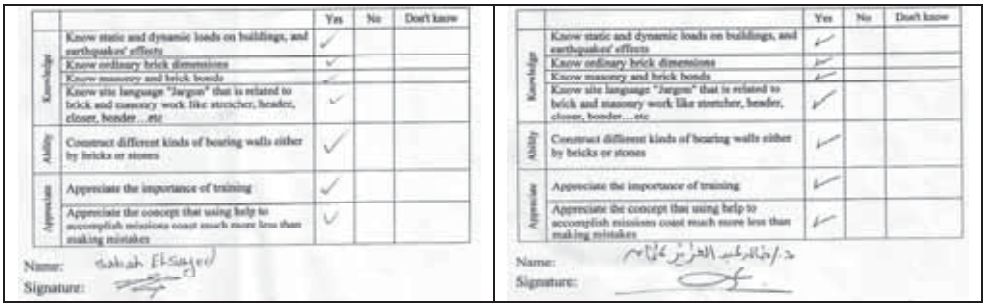
The level's physical context:

The site is nearby a railway line so every time the train comes, it causes a lot of earth vibrations which is similar to earthquakes. The player is supposed to start building his wall from above the zero level, so foundations are already laid. Stones and bricks are available and the player should use them to build walls.

The game:

Now, *Ali* has to train himself how to build a bearing wall either by stones or bricks. He has many practicing sessions with different building regulations such as; "use Flemish bond", "use English bond", "use uncoursed squared stones" and so on. *Ali* may ask *A'AM Fathy* to help him in each session. If he did so, *A'AM Fathy* shows him drawings and sketches about the building scenario. Whenever *Ali* finishes a session, he asks *the Boss* to check it. In this case, *the Boss* foresees an illustrative presentation that shows a train goes speedily nearby the construction site. This action causes vibrations and lateral forces. If *Ali's* wall has structural faults, the foreseeing presentation would present cracks in the wall. In this case, *Ali* may ask *A'AM Fathy* again for his help. *A'AM Fathy* tells him about the lateral forces effects on the bearing walls and what one has to take care about while building such a wall. Now, Ali has the opportunity to retry the building session. If Ali totally fails to build a stable wall, *A'AM Fathy* represents an illustrative detailed presentation about how to build this type of wall. In these practice sessions, help is for free and consume no credit points. Success adds extra points to the player's credit while having faults or total failure decreases the player's points.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



		Yes	No	Don't know
Knowledge	Know static and dynamic loads on buildings, and earthquakes' effects	✓		
	Know ordinary brick dimensions	✓		
	Know masonry and brick bonds	✓		
	Know site language "Jargon" that is related to brick and masonry work like stretcher, header, closer, bonder…etc	✓		
Ability	Construct different kinds of bearing walls either by bricks or stones	✓		
Appreciate	Appreciate the importance of training	✓		
	Appreciate the concept that using help to accomplish missions coast much more less than making mistakes	✓		

Name: Nahlah El-Sayed
Signature:

		Yes	No	Don't know
Knowledge	Know static and dynamic loads on buildings, and earthquakes' effects	✓		
	Know ordinary brick dimensions	✓		
	Know masonry and brick bonds	✓		
	Know site language "Jargon" that is related to brick and masonry work like stretcher, header, closer, bonder…etc	✓		
Ability	Construct different kinds of bearing walls either by bricks or stones	✓		
Appreciate	Appreciate the importance of training	✓		
	Appreciate the concept that using help to accomplish missions coast much more less than making mistakes	✓		

Name:
Signature:

Issue five: "Basement".

The level's construction problem:

To use the RC to build a retaining wall.

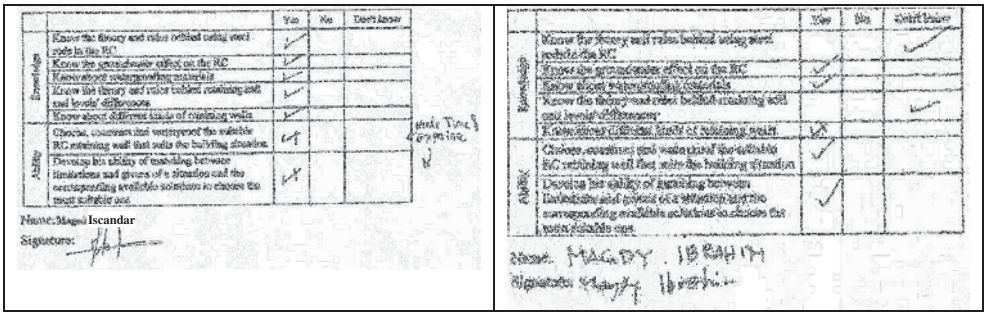
The level's physical context:

The site is already excavated. The building is a multi story building. The basement's clear height is 4.5 meters. Its finish floor level is 3m below the zero level. The building is adjacent to one of the land edges. The building location is nearby a cultivated land. The basement retaining walls will be RC. The groundwater table level will be given.

The game:

Ali participates in building the village's school. He would build the retaining walls of the basement floor and RC. would be the construction material. He should compose a sketch that shows how would be the wall section. The operation would be as if he is composing a machine by arranging its components. After that, the retaining walls would be executed according to these sketches. When he finishes, he asks *the Boss* to check his work. If *Ali* forgot to add steel rods or added them in wrong locations, *the Boss* foresees an illustrative representation that shows the wall failure because of the retained soil pressure. When *Ali* asks *A'AM Fathy* for help, he tells him about the steel rods ability to resist tension forces. Also, he tells him about the pressure force of the retained soil and how it affects the retaining wall. Moreover, if *Ali* forgot to waterproof the wall or did so but forgot to protect the waterproofing membrane, *the Boss* foresees the wall's failure. In such case, *A'AM Fathy* tells him about how the groundwater causes rusting and how the rusty steel rods loose their ability of resisting tension. In each case, *Ali* has the ability to fix his faults and redo the solution.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



Issue six: "Help neighbor to divide a room".

The level's construction problem:

To build a partition wall by using bricks as a construction material.

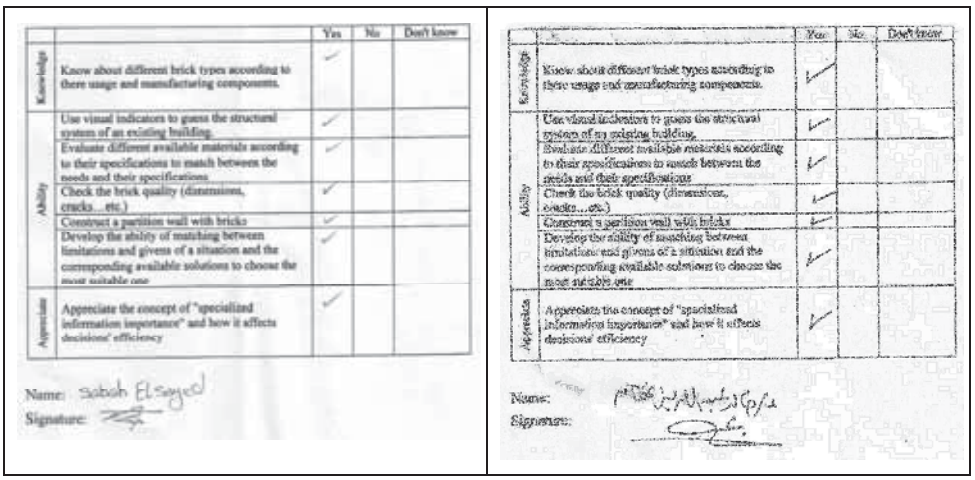
The level's physical context:

The main building is a skeleton system building but *Ali* has no confirmed information about that. The space to be divided is in the second floor, only bricks are available.

The Game:

Ali's neighbor has asked him for help. He needs to divide one of his rooms into two spaces. He asked *Ali* to do it fast, stable and cheap. In the first, Ali should check the building to know its structural system; is it bearing walls or skeleton system. He should search for visual indicators to help him to know the structural system of the building. Then, when he is sure about the structural system of the building he should investigate the available different kinds of bricks and know the specialized data and price of each. He is supposed to choose the most appropriate bricks that fulfill his constructional and financial needs. Then he should buy the suitable amount of brick to execute the partition and check the validity of the bricks before he accept them. Finally he should build the partition.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



		Yes	No	Don't know
Knowledge	Know about different brick types according to there usage and manufacturing components.	✓		
Ability	Use visual indicators to guess the structural system of an existing building.	✓		
	Evaluate different available materials according to their specifications to match between the needs and their specifications	✓		
	Check the brick quality (dimensions, cracks…etc.)	✓		
	Construct a partition wall with bricks	✓		
	Develop the ability of matching between limitations and givens of a situation and the corresponding available solutions to choose the most suitable one	✓		
Appreciate	Appreciate the concept of "specialized information importance" and how it affects decisions' efficiency	✓		

Name: Sabah El-sayed
Signature:

		Yes	No	Don't know
Knowledge	Know about different brick types according to their usage and manufacturing components.	✓		
Ability	Use visual indicators to guess the structural system of an existing building.	✓		
	Evaluate different available materials according to their specifications to match between the needs and their specifications	✓		
	Check the brick quality (dimensions, cracks…etc.)	✓		
	Construct a partition wall with bricks	✓		
	Develop the ability of matching between limitations and givens of a situation and the corresponding available solutions to choose the most suitable one	✓		
Appreciate	Appreciate the concept of "specialized information importance" and how it affects decisions' efficiency	✓		

Name:
Signature:

Issue seven: "Divide the shelter".

The level's construction problem:

To build a partition wall by using wood as a construction material.

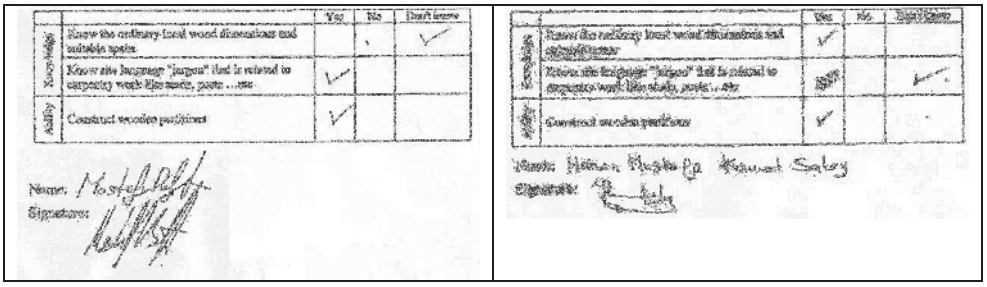
The level's physical context:

The exterior walls and roofs have been built. The building is a one story building and the ground floor is 30 cm above zero. The finish floor is a wooden cheap tiles. The required partition will reach the ceiling.

The Game:

The boss asked *Ali* to divide the wooden shelter into two spaces, one for sleeping and the other for eating. Wood is the only available material. *Ali* should start to use the wooden elements that are available to construct the partition. When he asks *A'AM Fathy* to help him he tells him stories about the concept of using skeleton and skin to clad it. In addition, he tells him about the local dimensions of the wood elements and he uses in his stories the local jargon that is related to the carpentry work.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



Issue eight: "River flood"

The level's construction problem:

To construct a lower floor of a bearing wall building by using bricks or stones as a construction material (shallow vaults).

The level's physical context:

The building location is nearby a flooding river. When it floods the water level becomes about 50 cm above the zero level. Only stones and bricks are available to construct the building. The building's height will be one story.

The game:

Ali's friend "*Abdel Rahman*" is from Sudan. He was talking with *Ali* about how much he feels sad because the river overflowed his house. *Ali* felt sad for his friend and wished to find a way to help him. *Ali* asked *A'AM Fathy* what to do. *A'AM Fathy* told *Ali* to find a way to avoid the water level. *Ali* thought to make the ground floor higher than the highest level of the river when it floods, but how can he establish the ground floor? *A'AM Fathy* represents an illustrative film about the theory and rules of transferring loads into curved surfaces. When *Ali gets the point, he* starts to use bricks to make these vaults. Then he asked *the Boss* to check and advise. When *the Boss* checks *Ali's* work, either he finds it ok or he finds faults. If there are faults, *the Boss* foresees an illustrative representation about the implications of these faults. For example, if *Ali* did not waterproof the sidewalls, water will go through the walls by capillarity and it will leaks into the space. Also, if he did not build the side walls to resist the lateral forces, the walls may be collapsed. In each case, when he asks *A'AM Fathy*, he explains what happened which gives *Ali* a chance to think of a solution.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?

		Yes	No	Don't know
Knowledge	Know about waterproofing materials.	✓		
	Know about some of the finish floor tiles.	✓		
	Know the theory and rules behind transferring loads by single curvature surfaces.	✓		
Ability	Use shallow vaults which base on side walls to construct flat, waterproofed, and raised above zero ground floor surface.	✓		

Name: DR. BASIL KAMEL

Signature:

Issue nine: "River flood II".

The level's construction problem:

To construct a lower floor of a bearing wall building by using wood as a construction material (wooden slab construction).

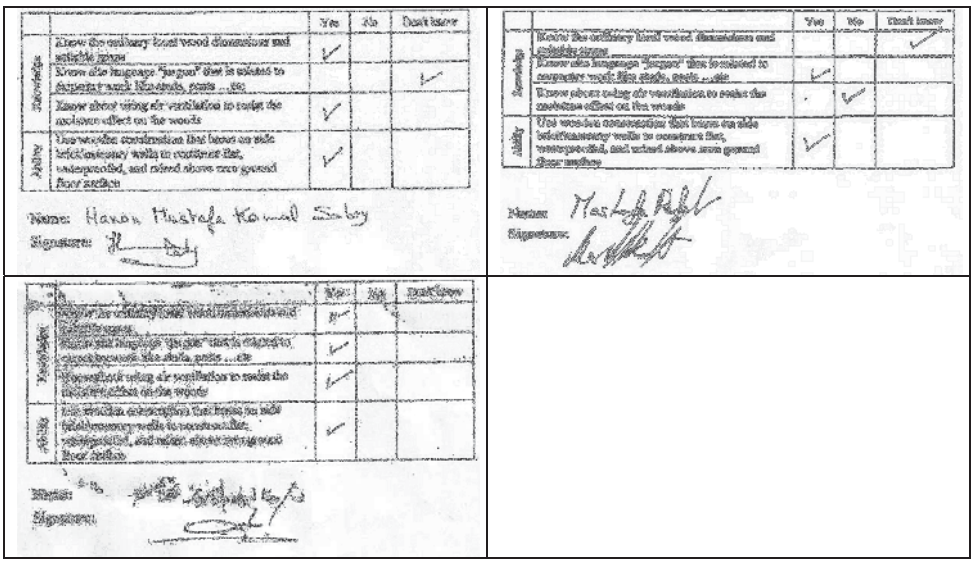
The level's physical context:

The building location is nearby a flooding river. When it floods the water level becomes about 50 cm above the zero level. A few amount of brick is available and plenty of wood to construct the building. The building's height will be one story.

The game:

Once again it is the river flood. *Abdel Rahman's* house is safe but he still feels sad because his brother's house, *Mahdy*, is not. *Abdel Rahman* called *Ali* for a solution as the previous solution does not fit in this case. *Mahdy* has not enough bricks or stones to construct vaults. He has an amount of brick that is only enough to construct a few short walls. But on the other hand he has plenty of wood. *Abdel Rahman* sent to *Ali* to ask him if he has a wooden solution for the situation. *Ali* should investigate about how to construct and protect against water a wooden floor that avoids the level of the river flood.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



Issue ten: "Help workmate II".

The level's construction problem:

To construct a lower floor of a bearing wall building by using OC/RC as a construction material.

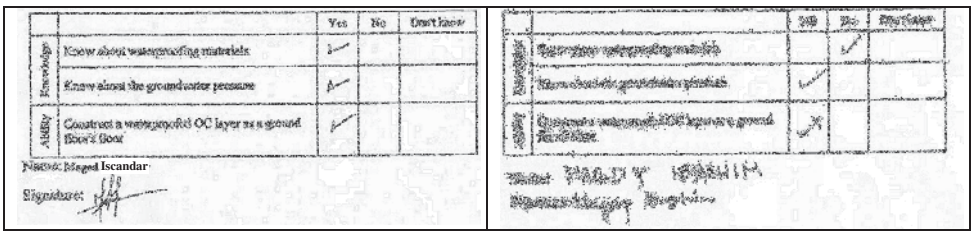
The level's physical context:

Exterior and interior walls have been built starting from foundations to the zero level. The building is a one story building and the ground floor is 30 cm above zero. No basement is there. The building location is nearby a cultivated land. Walls were built using bricks as a construction material. OC will be used to construct the ground floor's floor.

The game:

Ali is still helping his workmate to build his house. The *Boss* now asked *Ali* to construct the ground floor's floor. *Ali* will use the O.C. as a constructional material. If *Ali* forgot to ram the earth layers beneath the O.C. layer he might experience a floor settlement. Moreover, he should put in consideration the upward groundwater pressure and to protect the finish floor tiles against the ground water effect. If *Ali* forgot any of these issues, when the *Boss* checks his work he foresees an illustrative film that shows the implications of these faults.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



Issue eleven: "Site visits"

The level's construction problem:

To use lintels and arches to bridge wall openings with different construction materials.

The level's physical context:

The available construction material in each case; brick, stones, wood or OC/RC should be used. The wall openings width are different and the solutions will be according to each opening's width, available construction material and the surrounding context.

The game:

Ali decided to take a tour between all sites he participated in previously. Surprisingly, he found the same problem in each site; the workers there do not know how to bridge a wall opening. Doors and windows are awaiting there for a solution to be bridged. *Ali* should start composing a sketch in each case to tell the workers how to bridge the wall opening. Ali should match the surrounding urban context. He also should put in consideration the specification and the abilities of the available construction material.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?

		Yes	No	Don't know
Knowledge	Know about arch types and spans that matches each type			✓
	Know the site language "jargon" that is related to arches and lentils such as keystone, voussoirs, Springer…etc	✓		
Ability	Use different materials, bricks, stones, woods and OC/RC, to bridge wall openings using arches and lentils	✓		
Appreciate	Appreciate the concept of "*matching the surrounding architectural context*" as an architect's important duty	✓		

Name: Mostafa Refat

Signature:

Issue twelve: "Anti Monopoly".

The level's construction problem:

To construct an intermediate floor of a bearing wall building by using bricks/stones as a construction material by the Jack Arch system.

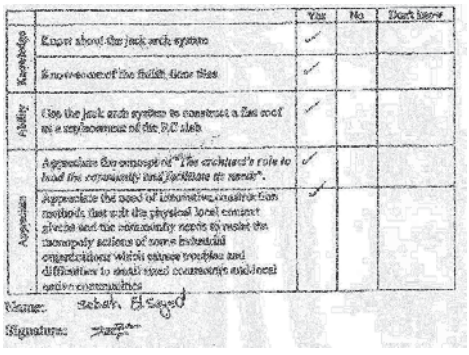
The level's physical context:

The building is a bearing walls one. The slab to be constructed is 5.00 meters above zero. The amount of steel rods that are available is only enough to construct few beams. A junior civil engineer is available to help *Ali* to calculate any structural calculations. Brick is available abundantly.

The game:

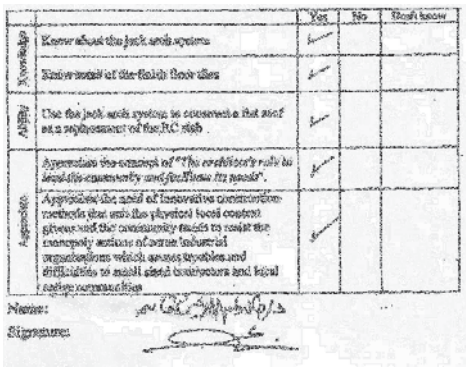
It is the phase of constructing an intermediate floor slab of a bearing wall building but there is a major problem. Suddenly, prices of the steel are increased about 20% because of a monopoly action. *Boss* feels so bad and because of this increase he will lose much more money than he can afford. The amount of steel rods he can afford, according to the new prices, is not enough to construct the needed RC slab. In addition wood as a construction material is not available in this case. *Boss* has to choose between two options; either looses his money or looses his reputation but *Ali* has another plan. When *Ali* asked *A'AM Fathy* to help him, he told him a story about using curved surfaces to bridge spans. He also showed him pictures of bridges that are constructed by arches and told him how people in Iran used to use shallow vaults in replace of R.C. slabs. Using these help, Ali should start to construct the intermediate floor by using shallow vaults that are constructed by bricks. In addition he should make the vaults upper face flat to add finish floor layers.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



		Yes	No	Don't know
Knowledge	Know about the jack arch system	✓		
	Know about the finish floor tiles	✓		
Ability	Use the jack arch system to construct a flat roof as a replacement of the RC slab	✓		
Appreciate	Appreciate the concept of "The architect's role to lead the community and facilitate its needs".	✓		
	Appreciate the need of innovative construction methods that suit the physical local context given and the community needs to resist the monopoly actions of some industrial organizations which causes troubles and difficulties to small sized contractors and local native communities	✓		

Name: Sabah El Sayed
Signature:



		Yes	No	Don't know
Knowledge	Know about the jack arch system	✓		
	Know about the finish floor tiles	✓		
Ability	Use the jack arch system to construct a flat roof as a replacement of the RC slab	✓		
Appreciate	Appreciate the concept of "The architect's role to lead the community and facilitate its needs".	✓		
	Appreciate the need of innovative construction methods that suit the physical local context given and the community needs to resist the monopoly actions of some industrial organizations which causes troubles and difficulties to small sized contractors and local native communities	✓		

Name:
Signature:

Issue thirteen: "Anti Monopoly II".

The level's construction problem:

To construct an intermediate floor of a bearing wall building by using wood as a construction material.

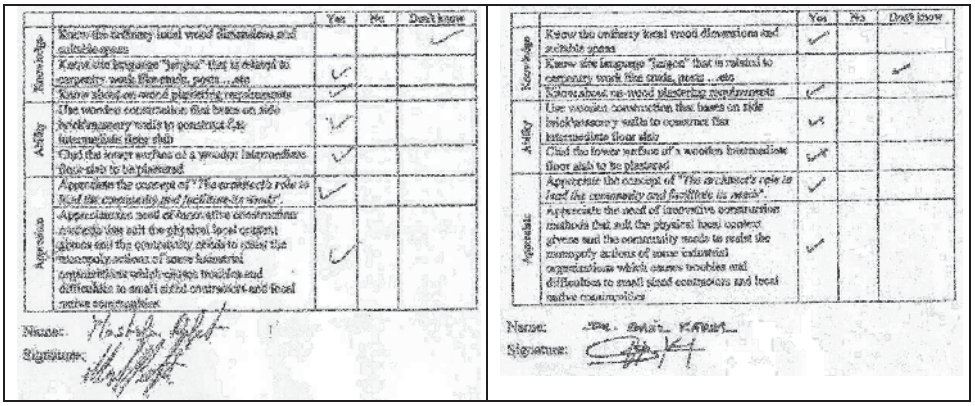
The level's physical context:

The building is a bearing wall building. The slab to be constructed is 5.00 meters above zero. There are no steel rods available at all. A junior civil engineer is available to help *Ali* to calculate any structural calculations. Wood is available abundantly.

The level's narrative context:

It is the phase of constructing an intermediate floor slab of a bearing wall building but there is a major problem. Suddenly, prices of the steel are increased about 20% because of a monopoly action. *Boss* feels so bad and because of this increase he will lose much more money than he can afford. *Boss* has to choose between two options; either looses his money or looses his reputation but *Ali* has another plan. Ali knows that there is plenty of wood that can be used as a construction material. He decided to ask *A'AM Fathy* to help him. When he did, he told him a story about using wooden structures in the past to construct the intermediate floors. He also showed him pictures and illustrative films about how to construct a wooden floor and to plaster its lower surface. Using these help, Ali should start to construct the intermediate floor by using wood and to prepare its lower surface to be plastered.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



		Yes	No	Don't know
Knowledge	Know the ordinary local wood dimensions and suitable spans			✓
	Know the language "jargon" that is related to carpentry work like studs, joists ...etc	✓		
	Know about on-wood plastering requirements	✓		
Ability	Use wooden construction that bears on side brick/masonry walls to construct the intermediate floor slab	✓		
	Clad the lower surface of a wooden intermediate floor slab to be plastered	✓		
Appreciate	Appreciate the concept of *"The architect's role is lead the community and facilitate its needs"*.	✓		
	Appreciation need of innovative construction methods that suit the physical local context given and the community needs to resist the monopoly actions of some industrial organizations which causes troubles and difficulties to small sized contractors and local native communities	✓		

Name:
Signature:

		Yes	No	Don't know
Knowledge	Know the ordinary local wood dimensions and suitable spans	✓		
	Know the language "jargon" that is related to carpentry work like studs, joists ...etc			✓
	Know about on-wood plastering requirements	✓		
Ability	Use wooden construction that bears on side brick/masonry walls to construct the intermediate floor slab	✓		
	Clad the lower surface of a wooden intermediate floor slab to be plastered	✓		
Appreciate	Appreciate the concept of *"The architect's role is lead the community and facilitate its needs"*.	✓		
	Appreciate the need of innovative construction methods that suit the physical local context given and the community needs to resist the monopoly actions of some industrial organizations which causes troubles and difficulties to small sized contractors and local native communities	✓		

Name:
Signature:

Issue fourteen: "Anti Monopoly success"

The level's construction problem:

To construct an intermediate floor of a bearing wall building by using OC/RC as a construction material

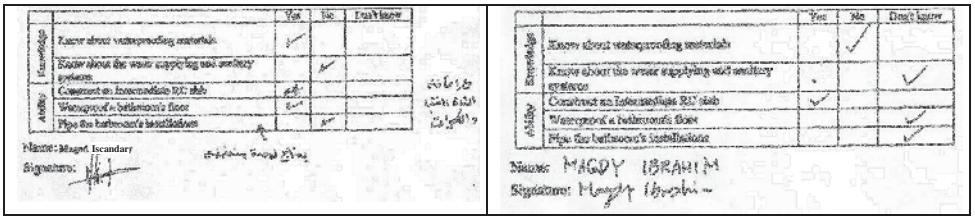
The level's physical context:

The building is a bearing wall building. The slab to be constructed is 5.00 meters above zero. RC will be used as a construction material. A junior civil engineer is available to help *Ali* to calculate any structural calculations. The slab would have a bathroom above one of its corners.

The game:

It is another bearing wall building and also an intermediate floor would be constructed but this time it would be a RC slab.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



Issue fifteen: "Mezzanine in the shelter".

The level's construction problem:

To construct an intermediate floor of a skeleton building by using wood as a construction material.

The level's physical context:

The mezzanine finish floor level is 3 meters above the finish floor of the shelter's level. Only wood are available to construct the mezzanine. Columns spans are wide so using wooden trusses and composite beams is a must.

The game:

Once again it is the wooden shelter. Workers need an additional space to be added in the shelter. *Boss* asked *Ali* to build the mezzanine. The main problem is the spans are bigger than the wooden beams lengths. Ali asked *A'AM Fathy* to help him. *A'AM Fathy* told him a story about the concept of trusses and the composite beams. Ali started to use this help and tried to construct the wooden floor.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?

		Yes	No	Don't know
Knowledge	Know the ordinary local wood dimensions and suitable spans	✓		
	Know site language "jargon" that is related to carpentry work like studs, posts …etc			✓
	Know about the theory and rules of trusses and composite beams	✓		
Ability	Use wooden trusses and composite beams that base on wooden skeleton to construct flat mezzanine floor slab	✓		

Name: Hanan Mustafa Kamal Sabry

Signature:

Issue sixteen: "Help workmate III".

The level's construction problem:

To construct a final roof of a bearing wall building by using bricks/stones as a construction material (domes and vaults)**.**

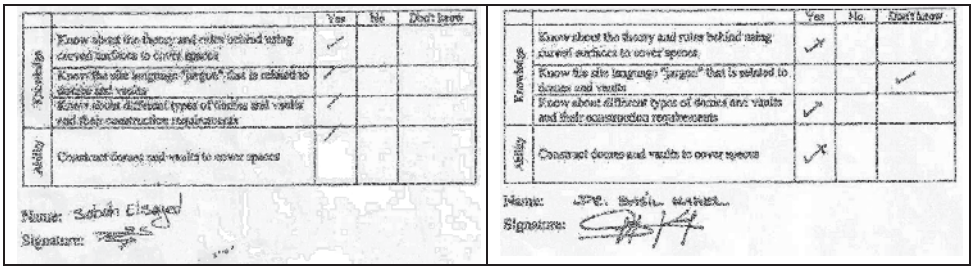
The level's physical context:

Exterior and interior walls have been built. The building is a one story building and the ground floor is 30 cm above zero. Walls were built using bricks as a construction material. In addition, domes and vaults will be used to cover the building spaces. All needed dimensions will be provided in each case separately

The game:

Construction is going to be finished. Now it is the final stage of building the workmate's marriage house. *Ali* is still helping and this time he has to construct the domes and vaults that cover the building's paces. Once again Ali should compose a 3d sketch for a dome and a vault to tell the workers how to build them. He may ask *A'AM Fathy* for help. In this case, *A'AM Fathy* shows him sketches and illustrative films about how to build domes and vaults.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



		Yes	No	Don't know
Knowledge	Know about the theory and rules behind using curved surfaces to cover spaces	✓		
	Know the site language "jargon" that is related to domes and vaults	✓		
	Know about different types of domes and vaults and their construction requirements	✓		
Ability	Construct domes and vaults to cover spaces	✓		

Name: Sabah Elsayed
Signature:

		Yes	No	Don't know
Knowledge	Know about the theory and rules behind using curved surfaces to cover spaces	✓		
	Know the site language "jargon" that is related to domes and vaults			✓
	Know about different types of domes and vaults and their construction requirements	✓		
Ability	Construct domes and vaults to cover spaces	✓		

Name: Dr. Sabah Hamed
Signature:

Issue seventeen: "Finishing the shelter".

The level's construction problem:

To construct a final roof of a bearing wall building by using wood as a construction material (raftered roof).

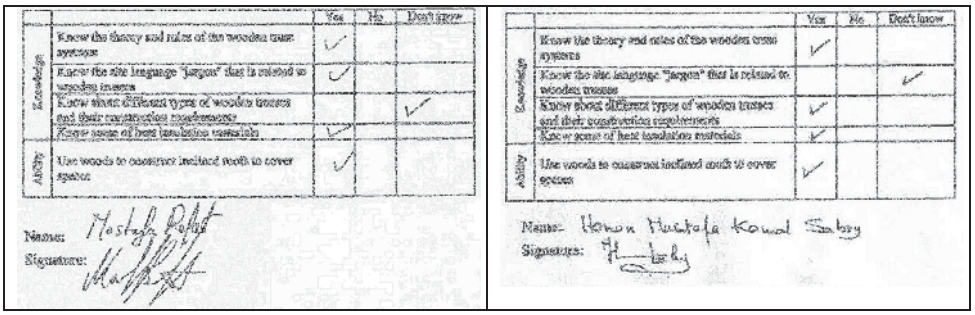
The level's physical context:

The building's walls are already constructed. The building location is in the desert. Wood will be the construction material. The column spans are wide

The game:

Construction is going to be finished. Now it is the final stage of building the wooden shelter. *Ali's* role is to construct the final roof. Ali should construct a wooden truss (king or queen) and to cover it and protect it against sunlight heat. In addition, he should add rain gutters to collect the rains.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



		Yes	No	Don't know
Knowledge	Know the theory and rules of the wooden truss systems	✓		
	Know the site language "jargon" that is related to wooden trusses	✓		
	Know about different types of wooden trusses and their construction requirements			✓
	Know some of heat insulation materials	✓		
Ability	Use woods to construct inclined roofs to cover spaces	✓		

Name: Mostafa Rabie
Signature:

		Yes	No	Don't know
Knowledge	Know the theory and rules of the wooden truss systems	✓		
	Know the site language "jargon" that is related to wooden trusses			✓
	Know about different types of wooden trusses and their construction requirements	✓		
	Know some of heat insulation materials	✓		
Ability	Use woods to construct inclined roofs to cover spaces	✓		

Name: Hanan Mustafa Kamal Sabry
Signature:

Issue eighteen: "Finishing the school building"

The level's construction problem:

To construct a final roof of a bearing wall building by using OC/RC as a construction material.

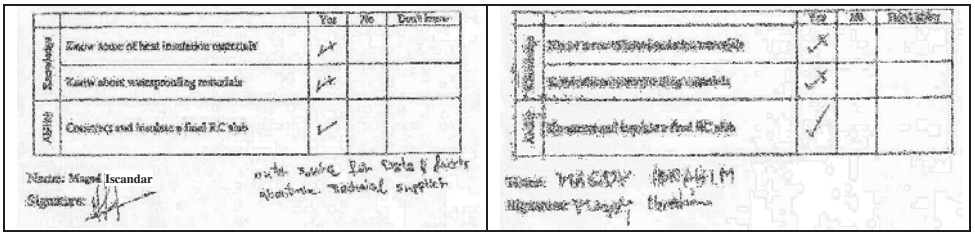
The level's physical context:

The building is already constructed; it is only the final roof that is remaining. The building location is nearby a cultivated land. The RC will be used as a construction material. The final roof has to be proofed against water and heat

The game:

Construction is going to be finished. Now it is the final stage of building the village school. *Ali's* role is to construct the final roof. *Ali* has to construct the RC slab, to protect it against water, to protect it against sunlight heat, to discharge the storm water and to add the finish floor tiles.

Based on your experience as an architectural educator and also based on the brief representation of the game and the level, Do you think this level in its current conceptual format may succeed to transfer and develop these knowledge, skills and abilities?



تشير معظم النظريات التعليمية الحديثة لأهمية دور الطالب في العملية التعليمية. وتتبنى معظم التوجهات التعليمية الحديثة مبدأ الاعتماد على التدريس بطرق "التعلم الاختباري" كأساس لتدريس العلوم وذلك لتدريب الطالب على مهارات البحث والتحليل والاستنتاج. وأيضا تهدف طرق "ألتعلم الاختباري" لتعليم الطالب كيفية الاعتماد على الذات في التعلم أو تدريبه على أن (يتعلم كيف يتعلم) وذلك لإعداد جيل قادر على مواكبة سرعة تطور العلوم الحديثة.

المشكلة البحثية:

رغم أهمية "التعلم الخبري" إلا أن بعض المجالات تقف عاجزة عن الاعتماد عليه بسبب المخاطر التي قد تنتج عن احتمالية الخطأ. ويظهر مجال التعليم المعماري كمثال واضح لتلك المشكلة حيث أن الخطأ في مجال عملية إنشاء المبنى مثلا يتسبب في مخاطر عديدة اقلها أهمية هو التكلفة المادية لإصلاح الخطأ. ولذا كان التوجه نحو التكنولوجيا الرقمية وبرامج المحاكاة المتخصصة لمحاولة الاعتماد على "التعلم الخبري".
ورغم ما تلعبه برامج المحاكاة التخصصية في مجال العمل المعماري من دور رائع في مجال دقة العمل وسرعة انجازه إلا أنها لم تؤدي دورا له ذات القدر في مجال التعليم المعماري. تمثلت المشكلة الرئيسية في مثل تلك البرامج في كونها برامج تخصصية تخاطب في المقام الأول من هم على علم ودراية بتلك البرامج وبالعلم الأكاديمي الذي تبني عليه عملها وبالتالي ففي الأعم الأغلب تحتاج لمتخصصين في المجال للتعامل معها ولا تهتم بأمر تبسيط المعلومة أو الإجراء بهدف توصيله لطالب العلم. أما المشكلة الثانية فكانت أن تلك البرامج تهدف في المقام الأول للمنتج النهائي أكثر من اهتمامها باستعراض إجراء الوصول لهذا الهدف والذي غالبا ما لا يكون ظاهرا للمستخدم. ولأن عملية التعليم تهدف أساسا لتدريب الطالب على إجراء الوصول للحل أكثر من الحل ذاته، فإن هذا أدى لصعوبة الاعتماد على تلك البرامج في عملية "التعلم الخبري".
والكثير من المجالات المشابهة تعرضت لمثل تلك المشكلة، وقد ارتأت تلك المجالات في الكثير من الأحيان في برامج التدريب والمحاكاة المماثلة لبرامج الألعاب الرقمية وسيلة تحقق الكثير من أهداف "التعلم الخبري". وبناء عليه كان من الضروري البحث حول مدى إمكانية الاعتماد على برامج الألعاب الرقمية كأداة لتعليم العمارة بهدف التغلب على معوقات اللجوء للتعلم الخبري في مجال التعليم المعماري.

الهدف من البحث:

وضع إطار نظري متكامل للعبة رقمية تُستخدم كأداة تعليمية لأحد مناهج التعليم المعماري.

منهجية البحث:

اعتمد البحث على عدد من المناهج البحثية لتحقيق مجموعة من الأهداف الإجرائية المؤدية للهدف الأساسي للبحث بحيث يتناسب كل منهج بحثي مع الهدف الإجرائي المرجو تحقيقه. وبذلك اعتمد البحث على:

- المنهج الاستقرائي التحليلي لما تم تناوله سابقا في هذا المجال.
- استخدام المنهج القياسي للقياس على التجارب السابقة والأهداف المرجوة من التعليم المعماري والمهارات المصاحبة للألعاب الرقمية المختلفة لبناء الإطار النظري للعبة الرقمية.

أقسام البحث:

جاء البحث في قسمين و ستة فصول.

القسم الأول:

ويختص هذا القسم بالبحث في مجال العملية التعليمية في العموم وعملية التعليم المعماري في الخصوص وتدخلات وإسهامات التكنولوجيا الرقمية في مجال التعليم وذلك في ثلاثة فصول.

الفصل الأول:

ويختص ببحث النظريات التعليمية في العموم والنماذج التدريسية (Teaching Models) المصاحبة لها والتعريفات الهامة في هذا المجال. وقد خلص الفصل لمجموعة من الفرضيات الخاصة بصفات وسمات الوسائل التدريسية الحديثة والتي من المفترض توافرها في أي وسيلة تدريسية معاصرة وخاصة في حال ما إذا كان التدريس يتم بطريقة "التعلم الخبري".

الفصل الثاني:

ويختص ببحث التعليم المعماري وتطوره وأهدافه وما تميز به عبر مراحل تطوره المختلفة. ويبحث أيضا المتطلبات الحديثة في التعليم المعماري الحديث وما يدعو له الباحثين في المجال من تطور وتحديث. وخلص الفصل لمجموعة من الفرضيات الخاصة بما يفترض أن يهدف له ويتميز به أي منهج معماري معاصر وأي عملية تدريس معاصرة في مجال العمارة.

الفصل الثالث:

ويختص ببحث التطور الذي حدث في عملية التعليم في العموم بسبب الاستعانة بالتكنولوجيا الرقمية الحديثة. ويتعرض الفصل لمجموعة من التعاريف والمفاهيم الهامة جدا والتي توضح الفارق الدقيق بين بعض المسميات التي يحدث لبس وخلط في استخدامها مثل "المحاكي" Simulator و"النموذج الرقمي" Model و"اللعبة الرقمية" Game و"لعب الدور" Role-Play.

القسم الثاني:

ويختص ببحث تاريخ وحاضر اللجوء للألعاب كأداة للتعليم والبحث في مدى إمكانية تحقيق هذا في مجال التعليم المعماري وذلك في ثلاثة فصول.

الفصل الرابع:

ويختص ببحث تاريخ وحاضر اللجوء للألعاب عموما والرقمية منها على وجه الخصوص كوسيلة للتعليم. ويناقش الفصل المهارات الشخصية لأفراد الجيل المعاصر والمتأثرة بالواقع الرقمي الذي نعيشه وأيضا المهارات الملازمة لبعض أنواع الألعاب الرقمية ومحاولات البعض لتوظيف تلك المهارات في العملية التعليمية. كما يستعرض الفصل ويفسر أسباب شكوك ورفض بعض المعاصرين لفكرة الاعتماد على الألعاب كأداة تدريس. وينتهي الفصل باستعراض مجموعة من المحاولات الجادة في مجالات متعددة للاستعانة بالألعاب الرقمية كأداة تدريب وتعلم.

الفصل الخامس:

ويختص بعمل دراسة تحليلية لعدد من الألعاب الرقمية المعاصرة لبحث مدى إمكانية الاعتماد على ما يماثلها في عملية تدريس العمارة وذلك استنادا لمجموعة الفرضيات السابق استنتاجها في الفصلين الأول والثاني. وقد خلص الفصل إلى أن تلك الألعاب، والتي تمثل مثالا لا حصرا لغيرها، تملك من الإمكانيات ما يسمح لها بعد تدخل مدروس من ذوي التخصص بأن تستخدم كأداة لتعليم العمارة.

الفصل السادس:

ويختص بوضع الإطار النظري للعبة رقمية يمكن من خلالها تعليم منهج الإنشاء المعماري لطلبة السنة الأولى في أقسام العمارة. ولقد قام الباحث في هذا الفصل بعمل تحليل لمتطلبات اعتماد المؤسسة التعليمية المعمارية في كلّ من الهيئة القومية لاعتماد المعماريون الأمريكيون (National Architectural Accrediting Board NAAB) والمعهد الملكي للمعماريين البريطانيين (Royal Institute of British Architects RIBA) وذلك لتحديد المهارات المفترض تنميتها بواسطة اللعبة محل التصميم. ومن خلال دراسة تحليلية مقارنة بين مجموعة من المناهج ذات الصلة بالإنشاء المعماري في أقسام العمارة في عدد من المدارس والكليات المصرية والأجنبية تم اختيار المحتوى العلمي الأكاديمي المفترض طرحه من خلال اللعبة. وقد خلص الفصل لوضع إطار نظري متكامل وسيناريو لعب وهيكل اللعبة محل التصميم.

النتائج والتوصيات:

بجانب الإطار النظري الذي انتهت به الرسالة فقد خلصت الرسالة لمجموعة من النتائج والتوصيات الهامة في مجال التعليم المعماري والتعامل مع الألعاب الرقمية. وكان أهم تلك النتائج والتوصيات على الإطلاق:

- الجيل الحالي من المتعلمين هو جيل يتصف بمهارات خاصة تختلف عن سابقيه. تلك المهارات تولدت لديه كنتيجة للواقع الرقمي المعاصر الذي يحيط به. وعليه فمن الضروري على كل العاملين في مجال التعليم إعادة دراسة الوضع الراهن للعملية التعليمية والوسائل التعليمية بهدف تناسبها مع سمات هذا الجيل وسبل تناوله للمعلومات وتعامله معها.
- برامج الألعاب في الوقت الراهن هي وسيلة واسعة الانتشار لنقل المعلومة للآخر. وعليه فليس من المتصور الاكتفاء بالرقابة على محتوى تلك الألعاب فقط من حيث ملائمته للسن ولكن من المهم أيضا التعامل معها بنفس التناول الذي يتم مع الأفلام والمطبوعات من حيث صحة المحتوى وعدم احتوائه على معلومات مغلوطة عن الآخر سواء عمدا أو سهوا.
- في مجال التعليم المعماري لا يوجد تقريبا منهج لا يمكن تناوله من خلال برامج تدريب وتعلم ترفيهية مثل الألعاب الرقمية ولكن الأمر في المقام الأول يحتاج لتضافر جهود ذوي التخصص لإعادة هيكلة المناهج ومحتواها بما يتناسب مع تلك الوسيلة الجديدة لتناولها.

الملخص العربي

جامعة عين شمس
كلية الهندسة
قسم الهندسة المعمارية

الدرجة: دكتوراه الفلسفة في الهندسة المعمارية
اسم الباحث: تامر سمير محمود حمزة
عنوان الرسالة: **التعليم المعماري وتكنولوجيا المحاكاة الرقمية**
منهاج لتطبيق التعلم من خلال برامج الألعاب كأداة لتعليم العمارة

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تاريخ المناقشة: / / تاريخ البحث: / /

الدراسات العليا:
ختم الإجازة: أجيزت الرسالة بتاريخ: / /

موافقة مجلس الكلية: موافقة مجلس الجامعة:

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كلية الهندسة – جامعة عين شمس

رسالة مقدمة كجزء من المتطلبات للحصول على درجة دكتوراه الفلسفة في الهندسة المعمارية

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