A COMPUTER AIDED LEARNING APPLICATION IN INDUSTRIAL ENGINEERING

ZEYNEP KAPLAN

IŞIK UNIVERSITY

2013

A COMPUTER AIDED LEARNING APPLICATION IN INDUSTRIAL ENGINEERING

ZEYNEP KAPLAN

B.S. Industrial Engineering Işık University, 2009

Submitted to the Graduate School of Science and Engineering

in partial fulfillment of the requirements for the degree of

Master of Science in

Industrial Engineering-Operations Research

IŞIK UNIVERSITY

2013

IŞIK UNIVERSITY

GRADUATE SCHOOL OF SCIENCE AND ENGINEERING

A COMPUTER AIDED LEARNING APPLICATION IN INDUSTRIAL ENGINEERING

ZEYNEP KAPLAN

APPROVED BY:

Assistant Prof Dr. Osman Murat Anlı
(Thesis Supervisor) _____

Assistant Prof Dr. Ali İnan _____

Assistant Prof Dr. Çağlar Aksezer _____

APPROVAL DATE: / /2013

A COMPUTER AIDED LEARNING APPLICATION IN INDUSTRIAL ENGINEERING

Abstract

Learning is the most central process in education where it's essential outcome being the assimilation of new skills, abilities, perspectives, attitudes, and knowledge. Learning is a life-long quest that is vital in today's information based economy. Educational institutions, though not exclusively, play a significant role in an individual's learning journey. Over the last two decades there has been significant research and development in methods of learning and teaching mostly spearheaded by institutions of higher education. At the core of these R&D efforts lie the need for improving the effectiveness of traditional methods of learning and teaching. Motivated by this need we designed and report here a computer aided learning application that helps better teach and learn some of the topics in inventory control and production planning in the discipline of industrial engineering. Computer aided learning environment provides time and location flexibility, enables asynchronicity, self-pacing, and experiential self-learning, extensively utilizes multi-media, and supports multiple types of learning styles. We designed our application in order to take advantage of all the benefits of this environment to reinforce the learning goals associated with our application area.

Our application is a learning tool named WashMac Game. The game has three levels that are aligned with the progress of the student. Each level aims to simulate the production and sales process and teaching to calculate the product amounts. There are animations for teaching and understanding more easily and accurate.

ENDÜSTRİ MÜHENDİSLİĞİNDE BİLGİSAYAR DESTEKLİ ÖĞRENME UYGULAMASI

Özet

Öğrenme kelimesi, bilgi edinmek, yetenek ve beceri kazanmak anlamlarına gelmektedir. Öğrenme işi sonucunda yeni yetenekler, davranışlar kazanılır ve bilgi öğrenimi gerçekleşmektedir. Eğitim kurumlarının bilgiye ek olarak kişisel öğrenme üzerinde de etkin bir rolü vardır. Son 20 yılda öğrenme ile ilgili önemli araştırmalar ve gelişimler yaşanmıştır. Klasik öğrenme olarak ifade edilen öğrenme çeşidinde araştırma geliştirmeler sonucunda ilerlediğini ve yerini elektronik öğrenmeye bırakmaya başladığını görüyoruz. Bu araştırmalara istinaden endüstri mühendisliği için bilgisayar destekli öğrenme üzerine bir çalışma yaptık. Envanter kontrolü ve üretim planlama konularını kapsayan bir tasarım hazırladık. Bilgisayar destekli eğitim sayesinde, kullanıcılar zaman ve yer konularında esneklik kazanılabilmektedir. Bir diğer faydası ise kullanıcılar başka bir insana, öğretmene ayrıca ihtiyaç duymadan öğrenim görebilmektedir. Tasarladığımız uygulamanın ismi WashMac Game olup toplamda 3 seviyeden oluşmaktadır. Basitten başlayarak üretim ve satış süreçlerinde üretilecek miktarları hesaplamayı, envanteri takip etmeyi öğretmeyi hedefliyoruz. Öğrenme stillerini baz alarak animasyonlar kullandık. Kullanıcının dikkati çekebilen bir oyun olmasına dikkat ederek tasarımı hazırladık.

Acknowledgements

There are many people who helped to make my years at graduate school most valuable. First of all I would like to thank to my advisor, Assistant Professor Osman Murat Anlı, very much for his great concern, his patience and help during this endeavor. Moreover, I would like to thank my supervisors, Mehmet Ekşi and Dilek Ayhan, at ING Bank, who has continuously supported my education.

Also, I am extremely grateful to my parents Deniz and Işıl and my fiancé Utku, for their trust, motivation and encouragement. They have played a great role on my personal and education development. They always motivate me for working hard.

In addition, I would like to a thank you to Assistant Professor Tankut Atan, for providing me with the industrial engineering courses.

Dedicated to my parents...

Table of Contents

Abstract i

Özet ii

Acknowledgements iii

List of Figures viii

List of Abbreviations ix

Chapter 1 Introduction 1

1.1 Introduction 1

1.2 Motivation 1

1.3 Contributions 2

1.4 Outline 2

Chapter 2 Learning Theory 3

2.1 Types of Intelligence 5

2.2 Types of Learning 6

2.2.1 Bloom’s Taxonomy 7

2.2.2 Bloom's Revised Taxonomy 10

2.3 Learning Styles 10

2.3.1 Tradional Learning 10

2.3.2 E-Learning 11

2.3.3 Project Based Learning 12

2.3.4 Computer Aided Learning 13

2.3.5 Learning by Doing 13

2.3.6 New Learning 14

2.4 Online Learning Communities 15
2.5 Learning Objectives and Learning Outcomes 17
2.6 Y & Z Generation 18
2.7 Industrial Engineers 19
Chapter 3 Literature Review 20
3.1 Visual Matrix Calculator for Undergraduate Students 21
3.2 Geogebra 22
3.3 The Virtual Company 26
3.4 Supply Chain Simulator 27
3.5 The Poker Chip Game 28
Chapter 4 Implementations 30
4. 1 Beer Game: 32
4.2 Prisoner's Dilemma 35
4.1 Taxonomies 37
4.1.1 Taxonomy of Inventory Control Policies 37
4.1.2 Taxonomy of Production Modes 38
4.1.3 Taxonomy of Facility Layout Types 38
4.1.4 Taxonomy of Mathematical Models 39
Chapter 5 WashMac Learning Game 40
5.1 Welcome Screen 43
5.2 First Level (Easy) 44
5.2.1 Terms 44
5.3 The Second Level (Medium) 47
5.3.1 EOQ Model 47
5.3.2 (r,Q), (s,S) policies 53
5.4 The Third Level (Hard) 59
5.4.1 Quizzes 59

5.4.2 Assembly Line 59

Chapter 6 Conclusion 61

Curriculum Vitae 62

References 66

List of Figures

Figure 2.1: Bloom's Taxonomy 8
Figure 2.2: Bloom's Revised Taxonomy 10
Figure 2.3: Differences between Synchronous and Asynchronous Learning 11
Figure 2.4: Differences between Synchronous and Asynchronous Tools 12
Figure 2.5: Learning Cycle 14
Figure 2.6: Differences between Old and New Learning 15
Figure 3.1: Solving the problem in Geogebra. 24
Figure 3.2: The least squares method in Statics. 25
Figure 3.3: The definition of the geometric probability 25
Figure 3.4: Virtual reality simulation in Geogebra 26
Figure 3.5: The Supply Chain Diagram 29
Figure 4.1: The introduction of Beer Game 32
Figure 4.2: The screen shot of the Beer Game 33
Figure 4.3: The rule of the Prisoner's Dilemma 36
Figure 4.3: Taxonomy of Inventory Control Policies 37
Figure 4.5: Taxonomy of Facility Layout Types 38
Figure 4.6: Taxonomy of Mathematical Models 39
Figure 5.1: Supply Chain Diagram 41

List of Abbreviations

CAL	Computer Aided Learning
CBS	Computer Based System
CBT	Computer Based Training
EPSS	Electronic Performance Support System
IBT	Internet Based Training
ICBL	International Conference on Computer-Aided Blended Learning
ICELW	International Conference on E-Learning in the Workplace
ICL	International Conference on Collaborative Learning
IELA	International E-Learning Association
IMCL	Interactive Mobile and Computer-Aided Learning
IMELS	Interactive Multimedia E-Learning System
LCD	Liquid Crystal Display
PBL	Project Based Learning
SBELP	Scenario Based E-Learning Products
SCORM	Shareable Content Object Reference Model
WBT	Web Based Training

Chapter 1
Introduction

1.1 Introduction

Learning is the key to success. Everyone has different intelligence and learning types [1]. Generally schools, universities using the classical learning method, which means there is a teacher teaches the specific subject in the classroom. After that there will an examination. Moreover some teachers give projects to reinforce the lesson [2].

Nowadays the technology will develop fast; also the educational alternatives will increase. Also computer aided educational products in academics are becoming wide spread [3]. These products can categorize as simulation, game based learning, e-learning. E–Learning is The Beginning of the End of Classroom Learning. Most of people have tablets, smart phones, laptops etc. so we can implement an application to every student will support their lessons. In this report, how an implementation will be in industrial engineering at Işık University is discussed. There will be many subjects about industrial engineering. I created a survey, and one of the questions is, "Which lesson do you mostly need in your working life?" Generally the answer is the "Production Planning." So we are focused on production planning and inventory management.

1.2 Motivation

In this project, I built an interface about the implementation also I want to show which features an implementation should have, because all students want to enjoy while learning. With these kinds of e-learning applications, the learning time will decrease also, they will learn easily, and more accurate.

1.3 Contributions

I showed a great effort to this project which is about the research and analyzing. I gather the graduated students' opinion in industrial engineering department from different universities. In addition, I also search other applications and articles about the educational e-learning. If I have enough software knowledge, I would like to develop the whole program.

1.4 Outline

I start to my project by clarifying some of the articles that I have read. Those articles were helpful to have an idea in my project. After literature review section, I give some explanation about what the e-learning is, learning types, and styles.

Chapter 2
Learning Theory

Learning is the permanent change in behavior [4]. Also, experience is the result of learning [5]. During the first half of the twentieth century, technology develops very fast. So electronically learning has big role in education. We will mention intelligence types, learning styles but basically we can divide into three, auditory, visual, and kinesthetic [6,7]. Confucius said that [8], "If I hear and I forget, if I see, I remember, if I do and I understand." In the e-learning the important thing is user can try, simulate and find the solution. So we want students try and solve the problems using an interface.

Important people who worked on special types of learning are the following:

Thorndike [9] worked on animal behavior. He was interested in the theory of connectionism [10]. Thorndike used a puzzle box to test the laws of learning. He put a cat in the puzzle box. The cat escapes to reach the fish at the outside. The cats are escaped in different ways and they reach the fish.

When cats had escaped it was put in again, and once more the time it took to escape was noted. The consequences of the successful trials, cats learn to escape in short time.

Ivan Pavlov [11,12] discovered classical conditioning. Ivan Pavlov was testing at salivation in dogs in response to being fed. His dogs don't begin to salivate when he entered the room. When the rings the bell and afterwards gave the fed. After several times, when dog hear the ring then he salivate [13].

John Watson interested in the psychological school of behaviorism [14]. He proposed that the process of classical conditioning. (Based on Pavlov's observations) It was able to explain all parts of human psychology.

Emotional responses were simply figures of response. Watson denied completely the existence of the mind or consciousness [15].

Watson believed that all individual differences in behavior were due to different experiences of learning.

Burrhus Frederic Skinner [16] is one of the most distinct behavioral thinkers. Operant conditioning is the best known for his theory [17]. Skinner believed that the best way to understand behavior is to look at the causes of an action and its consequences. He called this approach operant conditioning.

Skinner's [18] theory of operant conditioning was based on the work of Thorndike. Skinner has a new term in the Law of Effect which is, reinforcement behavior which is reinforced tends to be repeated.

Skinner interested in operant conditioning by experiments using animals. A "Skinner Box" was similar to Thorndike's puzzle box.
According to the Skinner operant conditioning means changing of behavior by the use of reinforcement is given after the response.

Skinner identified three types of responses that can follow behavior [18]:

- Neutral operant's: The probability of a behavior being repeated does not increase or decrease.
- Reinforces: The probability of a behavior being repeated is increased. Reinforces can be positive or negative.
- Punishers: The probability of a behavior being repeated is decreased. Punishment weakens behavior.

Albert Bandura [19] studied in social cognitive theory, therapy and personality psychology, and was also effective in the transition between behaviorism and cognitive psychology. Individuals that are observed are called models. In society children are affected many influential models, such as parents within the family, characters on TV. They pay attention to models and get their behavior. At a later time they may do the same behavior they have observed [20].

First, the child is likely to imitate those people, also it perceives as similar to itself. Consequently, it is likely to imitate behavior modeled by people the same sex as it is [21].

Second, the people around the child will respond to the behavior it imitates with reinforcement or punishment. If a child imitates a model's behavior and the consequences are rewarding then the child continues to perform the same behavior.

2.1 Types of Intelligence

Howard Gardner proposed the multiple intelligence theory. According to Gardner there are seven types of intelligence; two more were added later [22]. Generally most of the people have more than one type of intelligence [23]. The types of intelligence are:

Linguistic and Verbal Intelligence (Word Smart)

The people, who have verbal intelligence, think in words and to use language for explaining. Generally most of the people have verbal intelligence. It is obvious in poets, writers, and speakers.

Logical - Mathematical Intelligence (Number/Reasoning Smart)

The people who have mathematical intelligence, like calculations, and are interested in all mathematical operations. Like hypothesis, symbols etc. Logical intelligence is usually well developed in mathematicians and scientists.

Spatial Intelligence (Picture Smart)

The people who have spatial intelligence think in three dimensions. Sailors, pilots, painters, and architects have spatial intelligence. They can imagine in three dimensions and transfer their knowledge.

Bodily-Kinesthetic Intelligence (Body Smart)

The people who have bodily intelligence are generally athletes, dancers and runners. They also improve their intelligence of working out.

Musical Intelligence (Musical Smart)

The people who have musical intelligence realize rhythm, sound and tone. Also they can recognize, compose new songs. Generally, musicians have this intelligence.

Interpersonal Intelligence (People Smart)

The people who have interpersonal intelligence are interacting effectively with other people. They use verbal and nonverbal communication. Generally teachers, actors, and politicians have interpersonal intelligence.

Intra-personal Intelligence (Self Smart)

The people who have intra-personal intelligence understand other people's thoughts and feelings. They are very aware of their own feelings and are self-motivated. Also they guide other people according to their knowledge. This skill is obvious in psychologist and philosophers.

Naturalist Intelligence (Nature Smart)

The people who have naturalist intelligence care about the living thing. (Plants or animals)

Existential Intelligence

The people who have existential intelligence are interested in deep questions, such a human existence, and meaning of life, why people die etc.

2.2 Types of Learning

Basically there are three main types of learning styles [24]:

Auditory
Visual
Kinesthetic

Most people learn best through a combination of the three types of learning styles.

Auditory Learners: Hear

While listening auditory learners understand much easier and better. Generally they prefer to study with music. Other noises may disturb they need a quiet place. Also generally they do not forget what they heard.

Visual Learners: See

The people, who are visual learners, learn better by graphics or watching. In addition these kinds of people may have difficulties to focus while listening an explanation. They don't easily forget what they saw.

Kinesthetic Learners: Touch (Learning By Doing)

Kinesthetic learners prefer doing the activity. Simulations and trying are the best ways of learning for these kinds of people. They do not forget what they have done.

2.2.1 Bloom's Taxonomy

Benjamin Bloom (1956) identified three domains of educational activities [25]:

Cognitive: Mental skills (*Knowledge*)

Affective: Feelings areas (*Attitude*)

Psychomotor: Physical skills (*Skills*)

The goals of the learning process can be explained by Bloom's taxonomy. The learning objectives are having new skills, increasing knowledge, and/or attitudes [25,26].

Knowing and understanding are important for all students. If students know their learning type, it will be an advantage to understand or learn may become easier in the future.

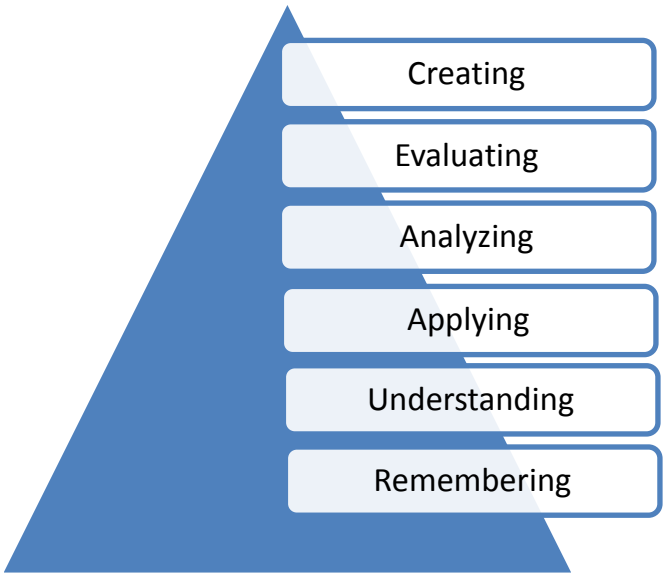


Figure 2.1: Bloom's Taxonomy

Cognitive Domain

The cognitive skills mean knowledge. It includes the development of intellectual skills. In other words, what students should know and understand by the time the course is completed. There are six major categories [27]. First one is the simplest towards complex.

Knowledge
Comprehension
Application
Analysis
Synthesis
Evaluation

Affective Domain

The affective skills contain emotionally behaviors, such as feelings, values, appreciation, enthusiasms, motivations, and attitudes [27]. The five major categories are listed from the simplest behavior to the complex.

Receiving
Responding
Valuing

Organizing

Characterizing

Psychomotor Domain

The psychomotor skills contain physical movement, coordination. These skills require practice. In other words, what students should able to do by the time? The seven major categories are listed from the simplest behavior to the complex [27].

Perception

Set

Guided Response

Mechanism

Complex Overt Response

Adaptation

Origination

There are two other psychomotor popular versions

Dave's (1975):

Imitation	Observing and trying exactly behavior after someone else.
Manipulation	Performing certain actions by following instructions.
Precision	Becoming more exact. Few errors are apparent.
Articulation	Coordinating a series of actions, achieving harmony.
Naturalization	Having high level performance become natural, without needing to think much about it.

Harrow's (1972):

Reflex movements	Reactions that are not learned.
Fundamental movement	Basic movements such as walking.
Perception	Response to stimuli. Visual, auditory, kinesthetic

Physical abilities	Developing for further development.
Skilled movements	Advanced learned movements.
No inconsistent communication	Effective body language.

2.2.2 Bloom's Revised Taxonomy

During the 1990s Lorin Anderson [27], a student of Bloom, revisited the cognitive domain and made fundamental changes. He renamed six categories were and rearranged the hierarchy to reflect a more active and accurate form of thinking.

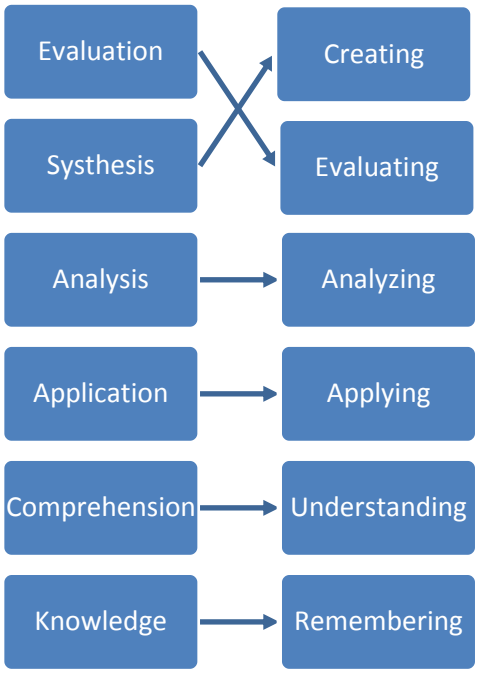


Figure 2.2: Bloom’s Revised Taxonomy

2.3 Learning Styles

There are 5 types of learning styles identified in the literature [28]. Traditional learning type is widely used in higher education. We see increasing examples of project based learning in university courses.

2.3.1 Tradional Learning

A traditional learning (classical education) is the basic type of learning. Classical education is language-focused; learning is accomplished through

words, written and spoken. All students should be in a classroom. Traditional learning needs teachers, books, and physical materials like blackboards, projectors and science laboratories [29].

2.3.2 E-Learning

E-learning is electronically supported learning and teaching [30]. This type of learning will be in out-of-classroom or in-classroom. E-learning generally using computers and also network transfer of skills and knowledge. Most of the applications are web-based or computer-based. Courses are delivered on the internet, audio or video, TV, or CD-ROM.

CBT (Computer Based Training), IBT (Internet Based Training) or WBT (Web Based Training) are refers to the E-learning.

The basic differences between e – learning and the traditional learning's are; Teachers which is using the traditional learning style, use boards, in e-learning boards are replaced by LCD monitors. In e-learning these is not a chalk or talk business, also not a one way process.

In classical learning should be synchronous, because students and teachers should be at the same place. But in e-learning it doesn't a must. The differences between synchronous and asynchronous are the following [31].

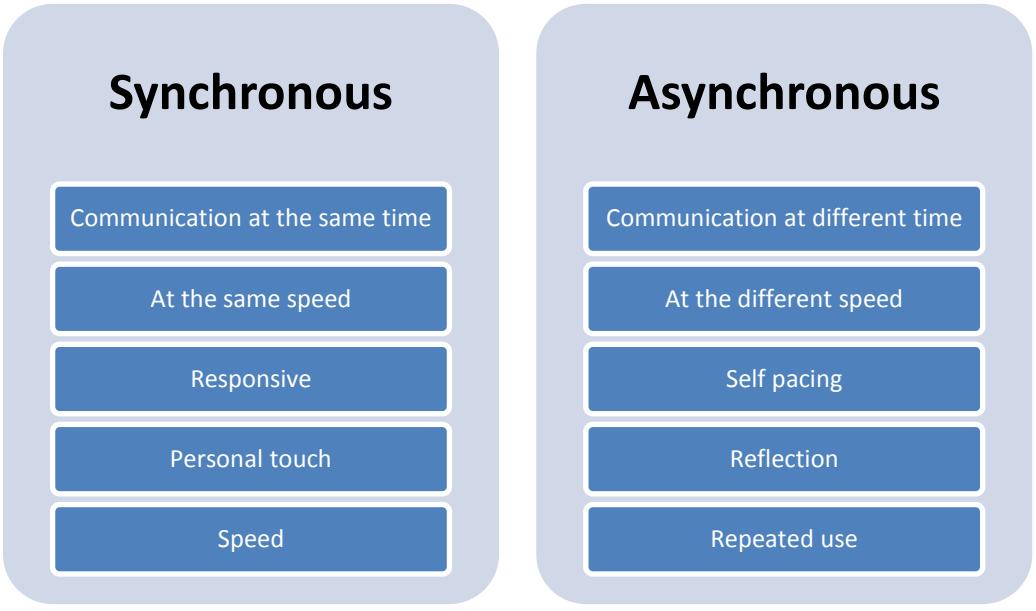


Figure 2.3: Differences between Synchronous and Asynchronous Learning

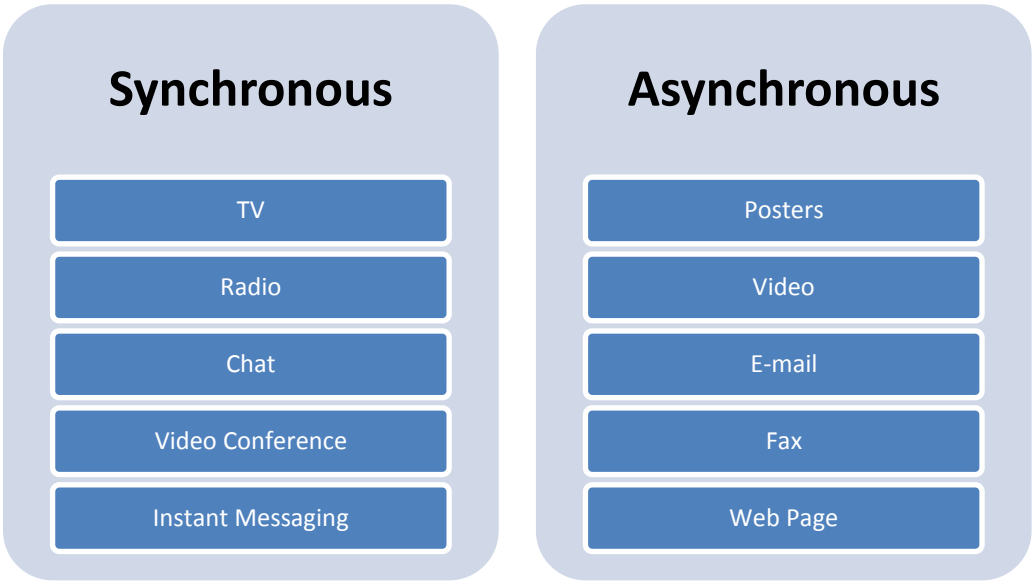


Figure 2.4: Differences between Synchronous and Asynchronous Tools

When we want to develop an e-learning application, the fundamental objectives are listed below:

100% Visualization of the concept
100% Transfer of knowledge
100% Memory retention
100% Results in the examination

Also, the e-learning services are, Web Classroom, Digital Classroom, CDs and DVDs, Online School Management System, Web Conferencing.

2.3.3 Project Based Learning

Project based learning is one of the most enjoyable means of learning. There are some courses that they give project at Işık University. But these projects are given for reinforcing. One of the most important features of project-based learning is the change from knowing to doing [32].

Project based learning (PBL) is a different teaching technique that practices new learning habits, emphasizing creative thinking skills by allowing students to find that there are many ways to solve a problem [33].

Project-based learning emphasizes learning activities that are long-term and student-centered. Unlike traditional, teacher classroom activities, students often must organize their own work and manage their own time in a project-based class.

2.3.4 Computer Aided Learning

Computer Aided Learning (CAL) or Computer Assisted learning [30] can be defined as learning through computers with subject learning packages.

Computer can be a guide to the student and also we can measure the students' knowledge with some questions. The best examples follow a formative assessment structure. This involves making an initial formative assessment by making out the incorrect answers. The teacher will explain what the students should do with each question. This is the formative learning stage. The next stage is to make a summative assessment by a new set of questions only covering the topics previously taught. After the summative assessment there will be an examination.

There is an example of computer based system (CBS), which is electronic performance support system (EPSS). These systems are a CBS that improves worker productivity by providing on the job access to information.

2.3.5 Learning by Doing

Learning by doing refers to the capability of students to improve their productivity by regularly repeating the same type of action. The productivity can be increased through practice, self-perfection and minor innovations. Learning by doing is about getting involved in an activity and, the process of doing this activity such as; how the activity works, how you find the activity [34,35]. Also what the activity make people think about, and what doing this activity enables people to do.

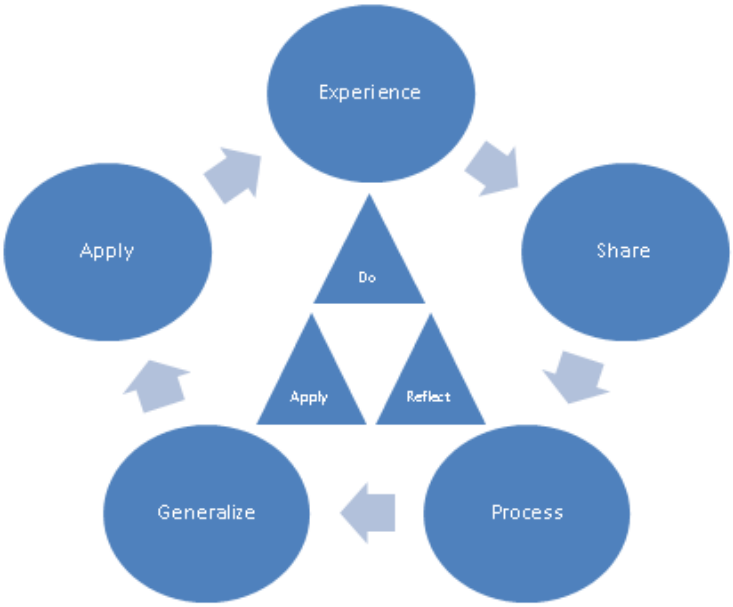


Figure 2.5: Learning Cycle

2.3.6 New Learning

The new learner is self-directed. Learners are users and they need to be responsible for their own learning and to select what they use. Also there are no right answers because students have to experiment, explore and think differently to face with a solution to a problem [36].

In addition, in the new learning's, there is more pressure to think, learn, find what works, very critical, evaluative and a decision maker.

In the new learning's, it is not an individual activity. Several people are usually better than one when it comes to problem solving and working out solutions [37].

Moreover, in the new learning's, will not be presented in print format. There is a new multimedia focus online so that students should be able to deliver the information more and more in visuals, graphics, audio, video etc.

New learning's should be [36];

Self - directed

Not scheduled

Online

Mobile (Can take it wherever student goes)

The features of new learning are and also the differences between old learning's and new learning's are listed below.

Figure 2.6: Differences between Old and New Learning

2.4 Online Learning Communities

Schoolsnet is a successful, resource-based website which provides a guide to every school in the UK, an online library, schools, sports, news and interactive lessons [37].

The BBC website is the most visited information site in Europe. BBC is already one the e-learning market's most important players producing digital learning objects of exceptional quality. The BBC's development of a digital curriculum will not only provide national curriculum content online but will provide media – risk learning tools for students everywhere.

The NewLearn.co.uk [38] website is done by the Guardian Newspapers group of companies. Created in May 2001 and this site is expected to license content to bigger portals as well as sell subscription packages.

New York Times learning network community provides teachers with resources such as lesson plans and conversation starters and students with Q&A sections.

Allexperts claims that it was the first large-scale question and answer website. Created in early 1998 and initially intended to supplement search engines. All answers are free and most are delivered the same day.

Big Chalk [39] is the most established of all learning communities in the US. With separate teacher, student, librarian. Bigchalk provides everything from print and digital resources to professional development courses and supplementary curriculum materials in areas.

Teachersource's [40] website aims to provide a listing of resources and advice to preschools teachers. Covering most media teachersource offers lesson plans and activities in the humanities, social sciences, math, science and technology and health. In its technology and teaching section, the site provides tutorials in software applications, live interactive forums with teaching experts content tips for e-learning, web based lessons and the annual think quest competition that challenges students to use the internet as a teaching and learning tool.

Mrs. Glosser's Math Goodies [41] is a free educational website featuring interactive math lessons, homework help, worksheets, puzzles, message boards. The site states that it contains over 400 pages of free math's activities and resources for students, teachers and parents.

Access excellence is a specialist national education website that uses the internet to provide high school biology and life science teacher's access to their colleagues, scientists' and resources. The website is a part of the National Health Museum [42].

At & T Learning Network [43] provides a range of information and resources for teachers, families and communities. For teachers there is a virtual academy

within the site that aims to provide teachers with the best in online teacher professional development resources. Encouraging teachers to use the technology infrastructure that's in place to learn how to use the technology to help improve teaching and learning, the academy offers free and fee-based e-learning courses.

Edna Online [44], the education network of Australia is the leading learning community for Australian teachers, providing information and resources about all aspects of learning and education. In its current form, and with a new user interface, Edna also offers a range of interactive facilities such as discussion, forums, chat, notice boards and an email alert service. Edna has attempted to establish itself as a one-stop-shop for teachers, students.

2.5 Learning Objectives and Learning Outcomes

A learning objective is what students learn or able to do at the end of the education. The important thing is students should not know this objective before. These are measurable outcomes; also learning objective is 'added value' of teaching. Student's performance is related with learning objectives [45].

The main categories of learning objectives are listed below: Learning objectives are aimed at the three domains of learning: knowledge, skills and attitudes. These are also termed the cognitive, psychomotor and affective domains of learning. These are Bloom's Taxonomy. Also objectives don't include the word 'know' or 'understand'. They include "state", "explain", "outline", "list" or "describe"

The advantages of using learning objectives organize and prioritize learning. Also it helps to focus the course and it helps students evaluate their own progress and encourage them to take responsibility for their learning [46,47].

Learning objectives should be "***SMART****"* [48]:

Specific - exactly what the learner will be able to do

Measurable - can be observed by the end of the course

Attainable - the participants within scheduled time and specified conditions

Realistic - the needs of the participant and the organization

Timebound - achievable by the end of the course

Learning outcomes is occurs after the learning objectives [47]. This means, after some time, the learning objectives become learners' attitudes, and then we called it learning outcomes.

The characteristics of good learning outcomes are listed below:

The specified action by the learners must be observable.

The specified action by the learners must be measurable.

The specified action must be done by the learners.

2.6 Y & Z Generation

There are many generations, those generations occurs according to the social, economic behaviors in time scales. %25 of the population in Turkey occurs with Y generations [49]. Our target students were born between 1994 – 1990. That means we consider the generation Y.

The generations are following:

The Silent Generation (1925-1945)
The Baby Boomers (1945-1964)
Generation X / Baby Busters (1965-1976)
Generation Y / Echo Boom / Millennial (1977-1996)
Generation Z (1997 – 2012)

Y generation is teenagers and young adults' parents worked very hard for money and status. Now, this group has different priorities for searching a job. They care less about salaries, and more about flexible working, time to travel and a better work-life balance.

Z generation is teenagers and young adults have following technologies, taking care of environment and having social responsibilities [50].

2.7 Industrial Engineers

Problem solving is the key role of industrial engineers. A successful industrial engineer thinks critically, approaches problems analytically, and is able to link diverse skills to tack problems [51].

Some of these skills involve the effective deployment of human and natural resources, the ability to integrate appropriate technologies, to maximize productivity, to provide leadership and motivation, and the capability to optimize so as to achieve the best results. The industrial engineer is able to look at the overall picture of a problem and apply his diverse skills to focus on the source of the problem.

Before I prepare this document, I created a survey for industrial engineering students and graduates. First question is, "Which lesson do you mostly need in your working life?" Generally the answer is the "Production Planning." The second question is, "Which lesson do you remember after your graduate?" the answer is the project planning, and the simulation. The third question is "Which lesson do you wish to learn more deeply?" the answer is, human resources, and the service planning.

In traditional learning, there are some difficulties for example, teaching the demand is so abstract. Variability of demand, the money which invests in inventory or the meaning of lead time are difficult terms to teach.

Chapter 3

Literature Review

Literature that I have read gives me an idea about how learning applications are.

The literatures help me to observe and model in different ways about the application. First of all, I want to give a part to the e-learning in the world. The International E-learning Association (IELA) [52] considers the knowledge and practice of e-learning. Each year they organize the International E-learning Awards for the best work in e-learning, mobile learning and blended learning. Also these are divided into two, first one is academic and Business/Industry. The following conferences are sponsored by IELA.

ICL, the International Conference on Collaborative Learning
IMCL, the International Conference on Interactive Mobile and Computer-Aided
Learning
ICELW, the International Conference on E-Learning in the Workplace
ICBL, the International Conference on Computer-Aided and Blended Learning

The Academic Awards of 2013 will announced at September 25, 2013 in the ICL.

The winner of 2012 is Econcordia which is the Concordia University's exclusive e-learning provider.

In literature part, I reported five articles which are similar to my topic of project.

First article is about the tool which has a basic matrix computation function and performs operations on a matrix.

Second article is about the tool which has visual and exploring math ideas, structures and relation in teaching of mathematics.

Third article is about the interactive multimedia e-learning system for industrial engineering students. Problem based learning approach to the teaching and learning through the delivery of realistic case problems.

Fourth article is about the scenario based e – learning product is developed for an introductory technology course. The product simulates a supply chain – a network of facilities and distribution systems.

Fifth article is about the tool to increase students' interest in and comprehension of supply chain management.

Articles are following;

"Visual Matrix Calculator for Undergraduate Students"

"Geogebra – A Complex Digital Tool for Highly Effective Math And Science Teaching"

"The Virtual Company: A Re-Configurable Open Shell for Problem Based Learning In Industrial Engineering"

"Supply Chain Simulator: A Scenario-Based Educational Tool to Enhance Student Learning"

"The Poker Chip Game: A Multi-Product, Multi-Customer, Multi Echelon, Stochastic Supply Chain Network Useful For Teaching The Impacts Of Pull Versus Push Inventory Policies On Link And Chain Performance"

3.1 Visual Matrix Calculator for Undergraduate Students

In this paper, Kanagawa and Shizuoka University have collaborated and develop the Visual Matrix Calculator (VISMAT) [53] which has a basic matrix computation function and performs operations on a matrix for Undergraduate Students. VISMAT was implemented in Java, so it could be used both as a frame based application and as an applet based application.

There are similar calculators like NinfCalc using Ninf and Point Five. The biggest difference is VISMAT is java based and also the system using a Gaussian elimination algorithm. It accepts at most 7x7 matrices.

They implement this calculator language system named LAMAX (Language for Matrix)

Lamax is a programming language for matrix computations and is implemented with Fortran77.

Linear equations such as Ax=b, where A is the coefficient matrix, b is the right hand side and x is the solution. A student is required to solve the equation using a given data A and b. In the Gaussian elimination algorithm, the following three steps which named, elementary row operation is required.

Multiply a row through by a non-zero constant
Interchange two rows
Add a multiple of row to another row.

VISMAT provides a way in which one can do the above steps in a window using a graphical user interface, basically VISMAT is a visual calculator but it is also a programming tool. It has been developed to be used in undergraduate level introductory courses on numerical analysis. It can be used as an application in other educational fields such the Simplex tableau in Linear Programming.

3.2 Geogebra

Geogebra [54] is the outcome of a Slovak national project named "Modernization of education at primary and secondary schools." It uses various types of mathematical systems. It is a complex digital tool for highly effective math and science teaching.

Previous Geogebra versions were designed for desktop computers and laptops. Geogebra is web-based also users can download to their PC. The latest version became a powerful integrated software environment which combines in its views: Algebra, graphics, spreadsheet, and construction all benefits of dynamic

geometrical systems, spreadsheets, graphic calculators. Their current project is Geogebra mobile.

Students can learn the following topics:

Planimetry: Investigation of relationship between elements of the right triangle, investigation of modifications of Pythagorean Theorem and its generalization. Also, investigation of relationships between angles in a circle.

Congruent and similarity transformations in the plane: Exploring the properties of symmetry and their application in problem solving.

Elementary functions: Investigation of functional dependencies through their graphical representations, investigation of properties of functions, applications of linear, exponential functions to solving of real problems.

Derivation of functions: Understanding concept of derivation of the function at a point using geometric meaning, investigation of derivatives of elementary functions using graphical representations, investigation of the properties of functions using derivation, use derivation to solve real problems focused on finding extremes of functions.

Probability: Modeling of random events and analysis of the received results, estimation of the probability using the random events by geometric probability.

Statistics: Statistical data processing and their graphical representation, investigation of the relationship between data.

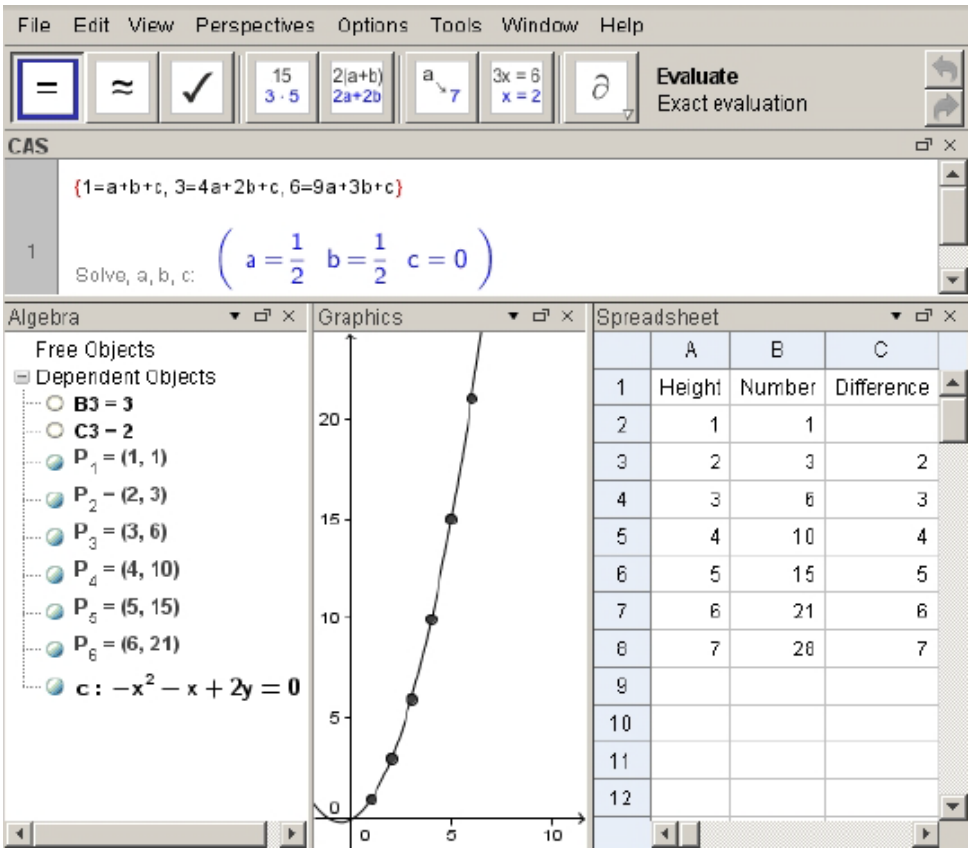


Figure 3.1 : Solving the problem in Geogebra. [54]

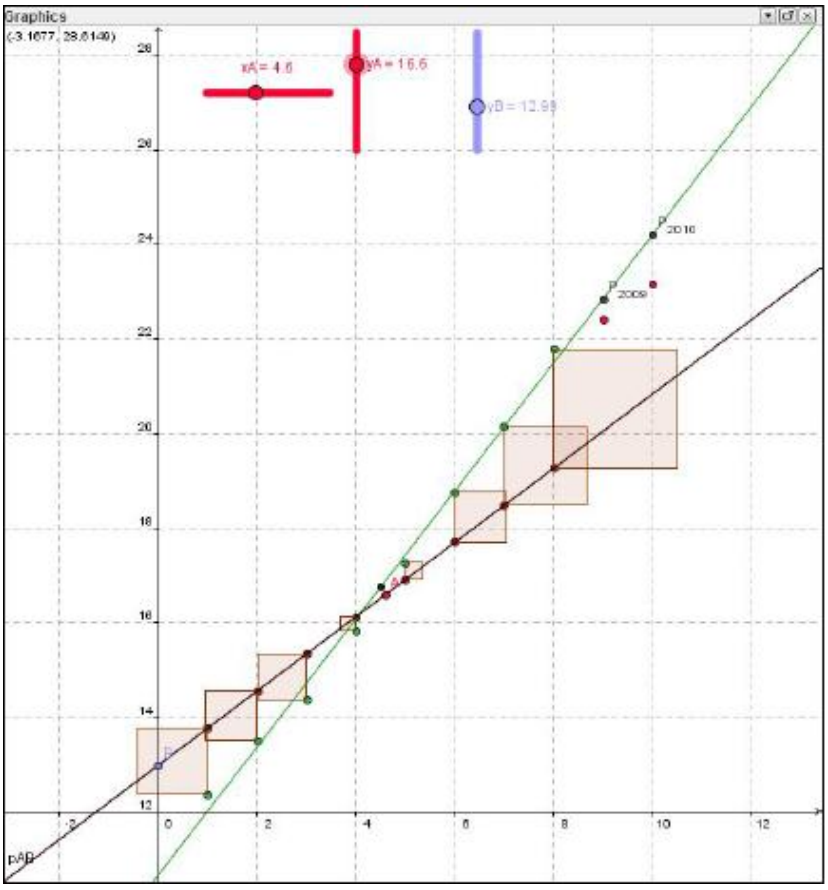


Figure 3.2 : The least squares method in Statics. [54]

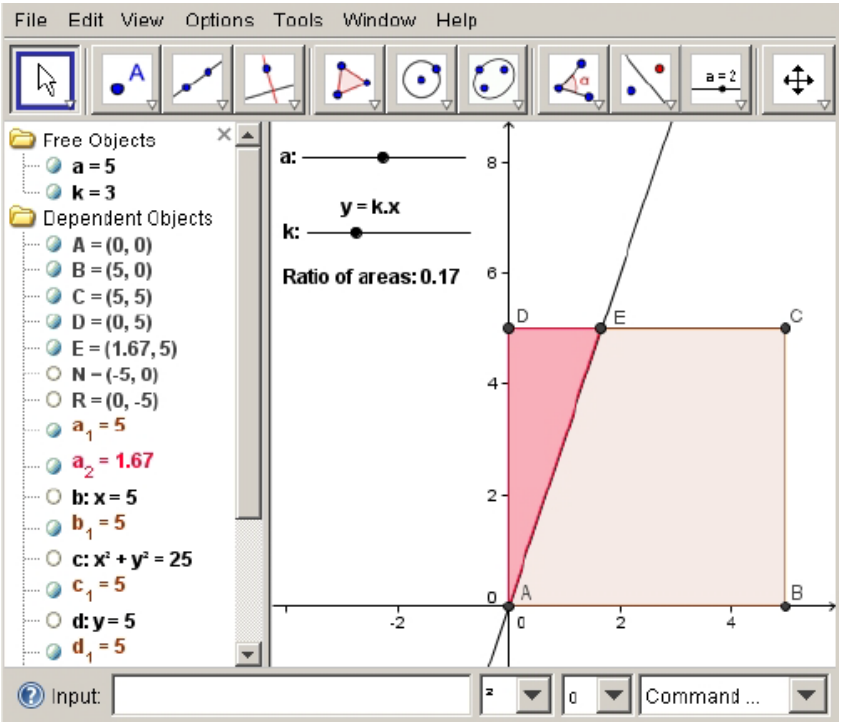


Figure 3.3 : The definition of the geometric probability [54]

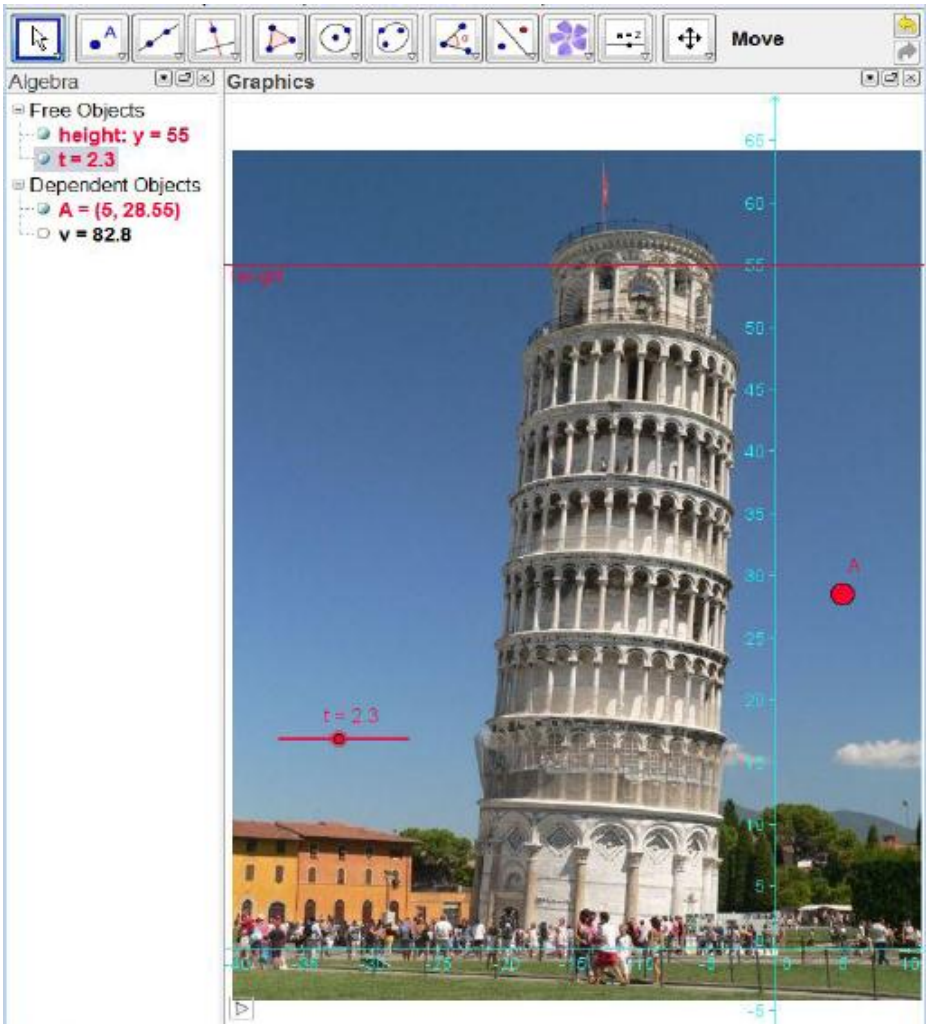


Figure 3.4 : Virtual reality simulation in Geogebra [54]

3.3 The Virtual Company

The Virtual Company is a Problem Based Learning Environment implemented at the University of Hong Kong. It is a problem based learning approach to the teaching and learning of industrial engineering through the case problems presented by two virtual companies. The learning tour is provided to students with three modules. The implementation is a web based interactive environment called The Interactive Multimedia E-learning System (IMELS). IMELS [55] presents the subject of industrial engineering through cases studies, problems and scenarios. The virtual company is the core of the teaching and learning shell of the system. The industrial engineer's role is to coordinate and manage the integration of specialists from various disciplines who are involved in the development of real world systems.

IMELS is structured to be a modular system that consists of reusable modules.

Module one (M1) provides multimedia portfolio of introductory resources to students about the major topics and issues about industrial engineering.

Module two (M2) contains comprehensive information regarding the "IE Knowledge Base" which provides online resources within industrial engineering.

Module three (M3) consists of case problems that are presented within the context of two "virtual companies", one from the manufacturing industry.

These main modules can be combined and organized into different structures so as to facilitate specific learning paths for different needs.

3.4 Supply Chain Simulator

Supply Chain Simulator [56] is a scenario-based simulation environment. It provides a unique way to reinforce the theory discussed in the classrooms. These products provide opportunity for the students to visualize and experience a practical scenario.

Scenario based e-learning products (SBELP) is a supply chain simulator which is developed in Macromedia Flash MX. The supply chain is used to deliver goods such as electronic equipment or a machine.

The parameters are; inventory holding cost, backorder cost, transportation cost etc. It is a single player product where student plays the role of a manufacturer while others are played by the computer itself. As the decision by one of the elements, affects the overall supply chain, the players' performance is judged based on the overall cost incurred by the supply chain during its operations. This can be done by minimizing two parameters – the inventory cost and the backorder cost.

A fundamental characteristic that affects the overall performance of the supply chain is the bullwhip effect. One of the key objectives of this SBELP is to understand and visualize this bullwhip effect this is caused by the delays in delivery of information upstream or materials downstream. It is similar to the Beer game.

Simulation based educational products are an active learning tool. It uses in management, engineering, sciences education. Students used basic cognitive skills as in Bloom's taxonomy which is knowledge, comprehension, and application. Intermediate cognitive skills, such as analysis was practiced by some students during the education period. As I mentioned before the product is single player, but they are working to make it multiplayer product where each element is played by the other students.

3.5 The Poker Chip Game

The poker chip game [57] is a based on a multi-product, multi-customer, multi-echelon, stochastic supply chain network. It aims to teach the impacts of pull versus push inventory policies on link and chain performance. Traditional push models (economic order quantity, reorder point and min max inventory models) and the elements of the new pull models (Just in time and theory of constraints) are illustrated.

The objectives of playing the poker chip game are:

> The impact of a supply chain managing by traditional inventory models are (reorder point/economic order quantity or min/max) on other links and on the production / distribution system.
> An effective supply chain needs the type of goals, strategies, policies, procedures, and measures.

In this game there are six retailers, two region warehouses, one central warehouse and one factory producing three products, red, blue and white chips.

The purposes of the poker chip game are;

The differences between traditional single-item and single firm inventory in multi-item, multi echelon production system.

Becoming students to recognize a logical of production or distribution system for multi-item and using theory of constraints and just in time.

The poker chip game looks like the Beer game. The main differences between beer game and the poker chip game is, poker chip game using a traditional distribution network, and a multi-product, multi echelon production / distribution system with multiple customers in a stochastic demand environment.

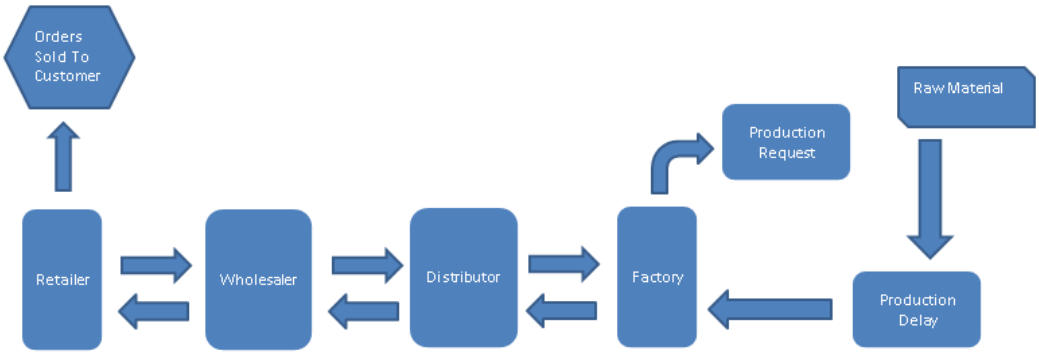


Figure 3.5 : The Supply Chain Diagram

Chapter 4
Implementations

I want to give a place to some people who have inventions about the e-learning tools.

Increasing scope of work in this area, formulating development standards are becoming important. Shareable Content Object Reference Model (SCORM) [58] is "A collection of standards and specifications for web based e-learning."

SCORM is an e-learning standard in which the goal is to have learning objects reusable, accessible, and durable [59].

Hantsaridou, Theodorakakos and Polatoglou [56] developed a multimedia module for climate-simulation. The proposed method is free from numerical or algebraic computations. To aim of this tool is to motivate students into learning and teach the fundamental principles of the subject. (2005)

Chua [56] connected the gap between the gaming and simulation. He provided a template for designing and implanting knowledge management simulation game. He also used this template to show the effectiveness of a simulation game. (2005)

Santos [56] implemented an interactive teaching which introduces students to the results of financial policies of different nations. This tool is internet based and also it is different from other simulators because it allows students to interact with each other. (2002)

A modified beer game is presented in Sparling [56]. Beer game is one the most popular games in supply chain education that has introduced the problem. The game is taken to the next step by helping students or managers plan to over those problems and manage it. (2002)

Holweg and Bicheno [56] describe how an interactive simulation model is used to demonstrate supply chain parameters and to model improvements to a supply chain. (2002)

Khaled [56] developed an equipment replacement game which is presented to help in teaching about the different effects of the strategies of buying or selling of equipment on the construction companies. (2001)

Ponce [56] implemented an educational tool for the analysis of the wireless communication. The tool is for the telecommunications students, because the characterization of radio channels can be understandable. Also the graphical visualization of the results allows students to understand the differences easily. (2001)

Anderson and Morrice [56] describe an implementation of java based, multiplayer, multi-group and distributed simulation game based on the classical beer game. A simulation game is nearly the same with the supply chain management principles and to test whether managers can use them effectively. (2000)

Alarcon and Ashely [56] implement a simulation game to test various lean production strategies and its impact on project's cost and scheduling. (1999)

Shifrony and Ginat [56] developed a simulation game for teaching communication protocols. The students act as protocol in the game. This method has improved the level of understanding and motivation. (1997)

Avolio [56] a simulation game, conducted on transformational and transactional leadership, is presented. The game is used in a second year MBA class. The result shows correlation between the game and the actual. (1988)

Curland and Fawcett [56] describe the problems with numerical data, operations management and finance using simulation games. (2001) A financial accounting and investment simulation game is developed and studied in classroom by Albrecht. The application on an industry simulation game in a business course is discussed in Margaret. (1995)

4.1 Beer Game:

The Beer game [60] was originally developed at the Sloan School of Management, Massachusetts Institute of Technology in the early 1960's and has been used for over four decades to teach systems thinking and system dynamics.

I would like to give an example of Beer Game.

There are 4 roles in the beer game, first one is the retailer, second is wholesaler, third one is distributor finally the factory. The aim of the game is managing the stocks, orders according to the demand.

Figure 4.1 : The introduction of Beer Game [60]

For instance Retailer sells the many types of beer, and this example we talk about X beer. The demand of X beer is 4 cases of beer / week. The retailer arranges the stock according to the demand. And the order comes to the retailer 4 week later. Which means, if I order today, then 4 week later the order will come.

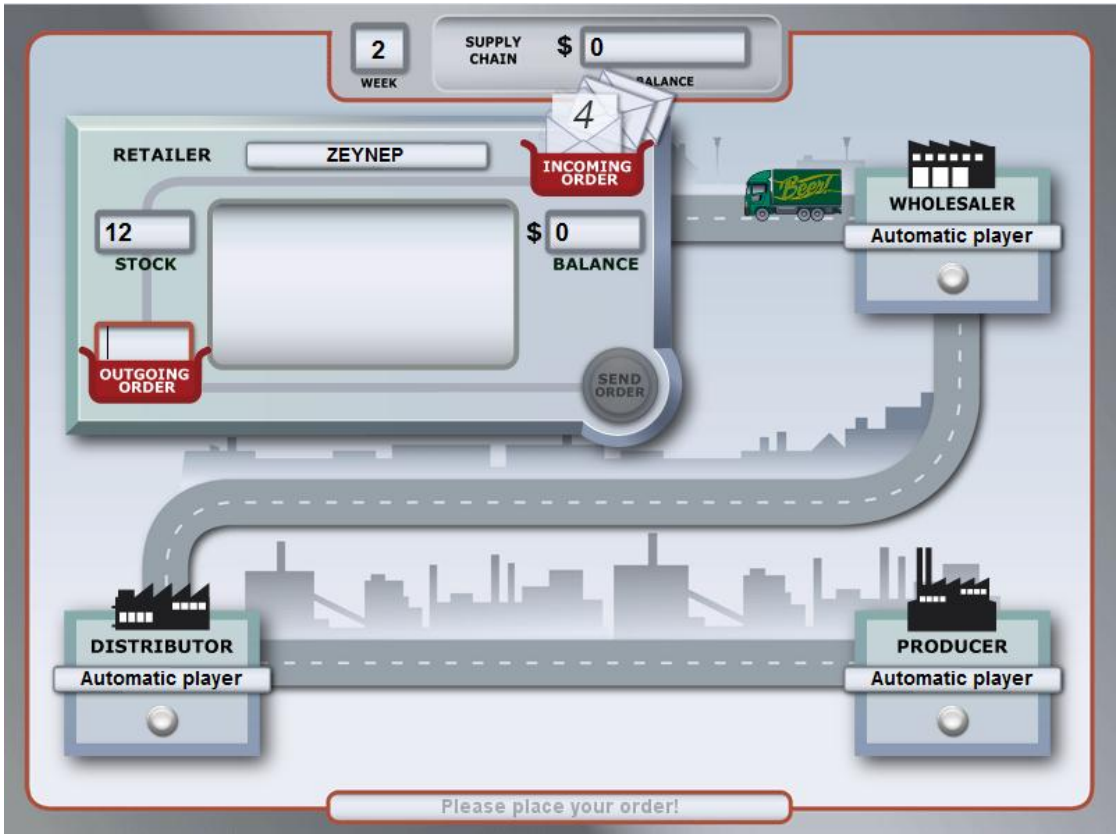


Figure 4.2 : The screen shot of the Beer Game [60]

The Retailer [61]:

Week, retailer sold 4 cases of beer/week as usual.

Week, the demand increases then, 8 case of beer/week because of the advertisement. Then the retailer order 8 cases of beer / week. This week retailer can cover 8 cases of beer. Then retailer order 8 cases of beer.

Week, the wholesaler brings 4 cases of beer. The retailer wants to take precaution so he/she ordered 12 cases of beer.

Week, the wholesaler brings 5 cases of beer. This means stock will remain 1 case. The retailer orders 16 cases of beer for covering the demand.

Week, the wholesaler bring 7 cases. At the end of the week, there is no stock. So he orders 16 cases of beer.

Week, the stock increases to 6 cases and those are sold.

Week, the wholesaler brings 5 cases, and 16 cases ordered.

Week, the stock increases to 5 cases. This is not enough to cover the demand so the retailer orders 24 cases.

The Wholesaler:

They take the order number of cases and they order number of gross from the factory. They order 4 gross as usual.

According to the demand they increase their order to 20 gross in the 6th week.

Week, the factory sent 6 gross, but the demand is 29 gross. So still it is not enough.
Week, the demand increases to 26 gross in a week.
Week, the wholesaler order 40 gross.
– 13. Week the wholesaler order 40 gross.
– 15. Week the demand decreases.

16. Week, the factory sent all orders, 55 gross. But after this week the demand is the same which is zero.

The Factory:

After the 6th week the demand was 40 gross but the factory sent 30 gross. After the 7th week, the stock is finished in the 2 weeks. In the 10th week, the demand was bigger than the 24 gross but they sent 22 gross to the wholesaler.

They cover the all demand in the 16th week and 17. Week the demand was 19 gross. And it is 18. Week there is no demand.

19. week, there are 100 gross in the factory stock, 220 gross in the wholesaler stock, 93 cases of beer in the retailer stock. Which means all stock will sell more than one year.

This is called “Bullwhip Effect” which means, is an observed phenomenon in forecast-driven distribution channels It refers to a trend of larger and larger swings in inventory in response to changes in demand, as one looks at firms further back in the supply chain for a product.

4.2 Prisoner’s Dilemma

The prisoner's dilemma [63] is a game analyzed in game theory. It was framed by Merrill Flood and Melvin Dresher. Prisoner’s Dilemma is named by Albert Tucker.

There is a crime, and two members are arrested and imprisoned. Each prisoner does not have communication with the other prisoner.

In this classic version of the game, collaboration is dominated by betrayal; if the other prisoner chooses to stay silent, then betraying them gives a better reward (no sentence instead of one year), and if the other prisoner chooses to betray then betraying them also gives a better reward (two years instead of three) Because betrayal always rewards more than cooperation, all purely rational self-interested prisoners would betray the other, and so the only possible outcome for two purely rational prisoners is for them both to betray each other. The interesting part of this result is that pursuing individual reward logically leads the prisoners to both betray, but they would get a better reward if they both cooperated. In reality, humans display a systematic bias towards cooperative behavior in this and similar games, much more so than predicted by simple models of "rational" self-interested action.

There is also an extended "iterative" version of the game, where the classic game is played over and over between the same prisoners, and consequently, both prisoners continuously have an opportunity to penalize the other for previous decisions. If the number of times the game will be played is known to the players, the finite aspect of the game means that (by backward induction) the two prisoners will betray each other repeatedly. Game theory does not claim, however, that real human players will actually betray each other continuously. In an infinite or unknown length game there is no fixed optimum strategy, and Prisoner's Dilemma tournaments have been held to compete and test algorithms.

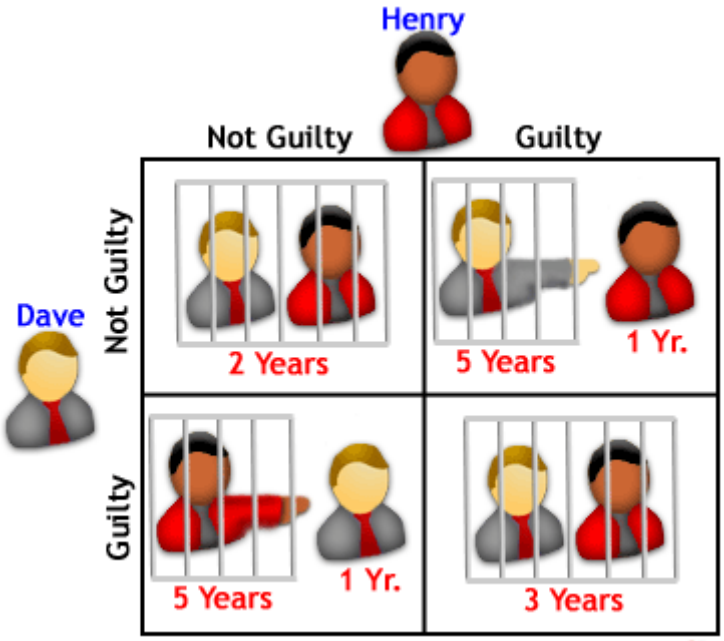


Figure 4.3 : The rule of the Prisoner's Dilemma [63]

4.1 Taxonomies

4.1.1 Taxonomy of Inventory Control Policies

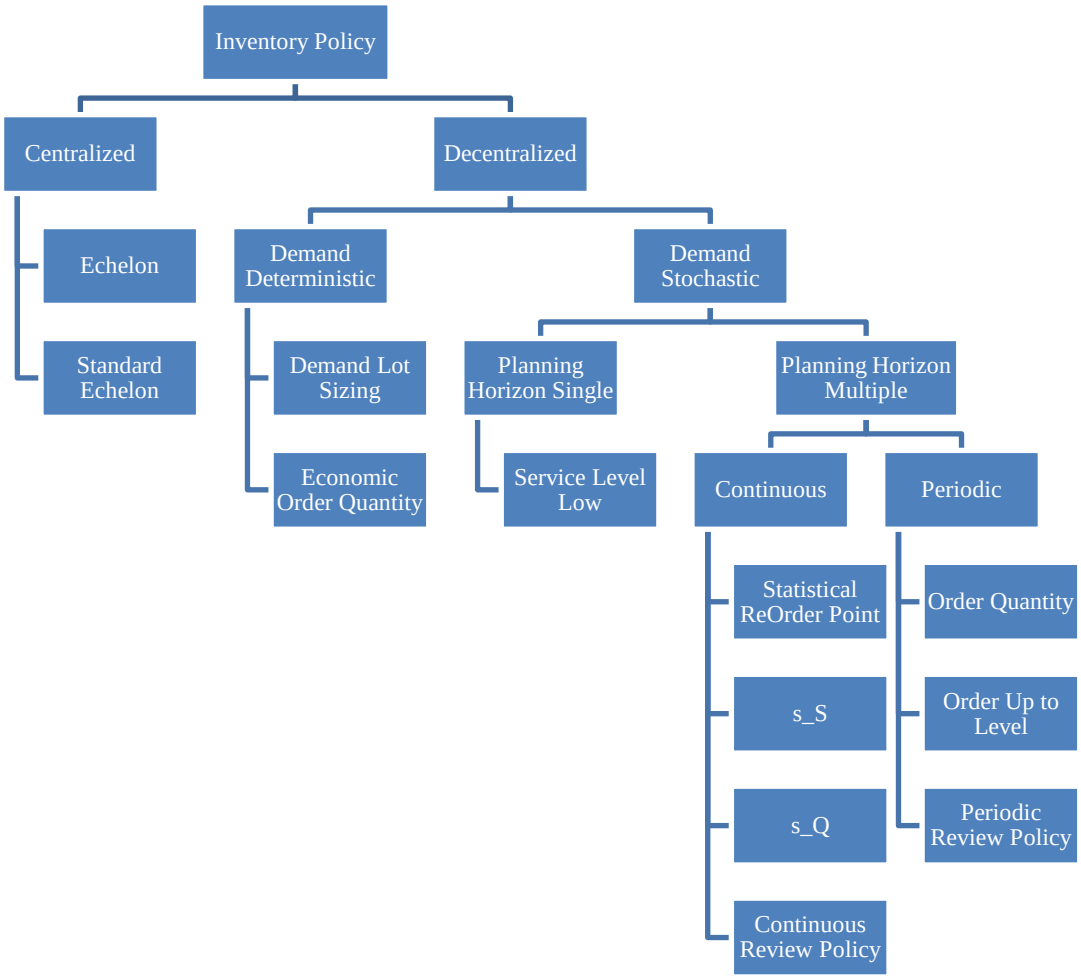


Figure 4.3 : Taxonomy of Inventory Control Policies

4.1.2 Taxonomy of Production Modes

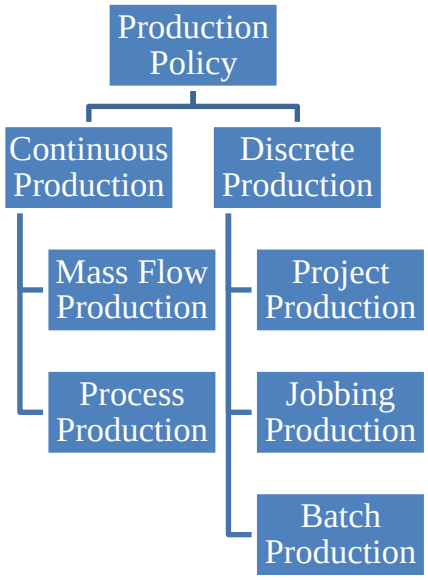


Figure 4.4 : Taxonomy of Production Modes

4.1.3 Taxonomy of Facility Layout Types

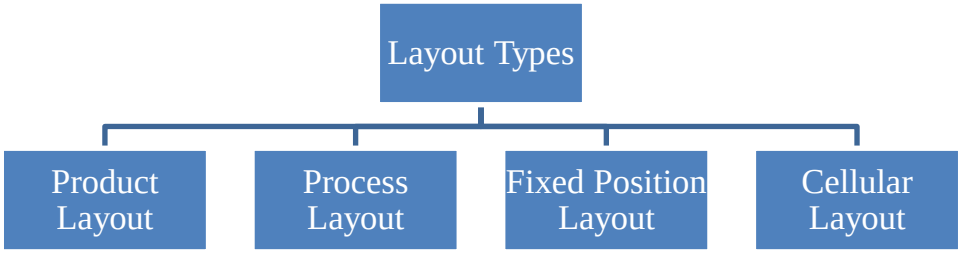


Figure 4.5 : Taxonomy of Facility Layout Types

4.1.4 Taxonomy of Mathematical Models

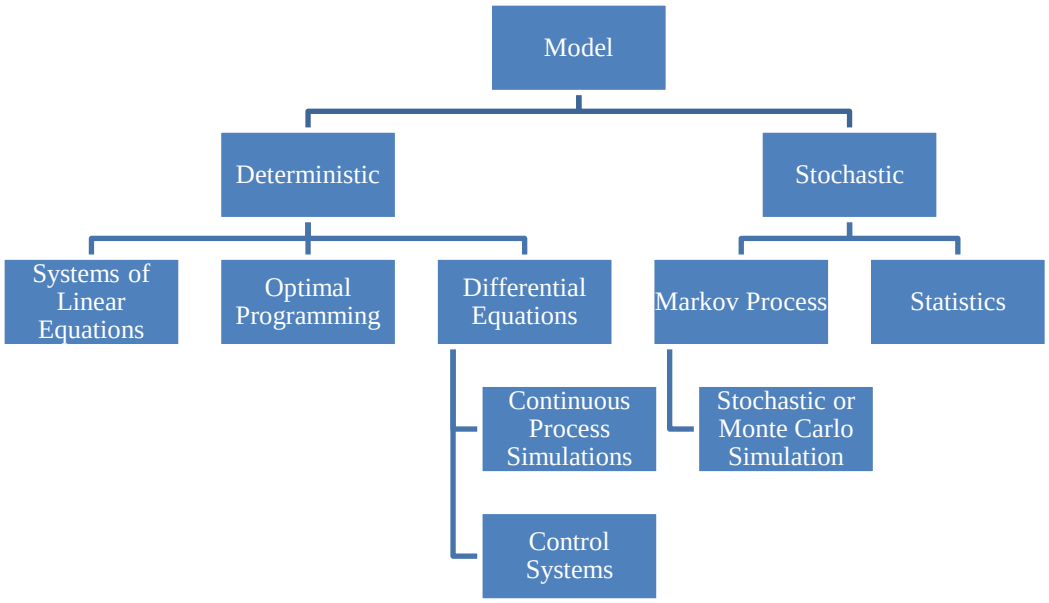


Figure 4.6 : Taxonomy of Mathematical Models

Chapter 5
WashMac Learning Game

Traditional teaching styles usually focus on abstract relationships represented by sets of equations. These relationships simplify and generalize performance or operations of system such as a production system or a warehouse. Unfortunately majority of students have difficulty learning through studying abstractions. Traditional teaching styles mostly invoke a language based inductive learning mode and ignore the other modes. We propose the design and the user interface of an interactive computer game The WashMac Learning Game to help students overcome the learning difficulties that they face.

WashMac is an inventory management and production planning game that takes place at a washing machine manufacturer. Users learn the fundamentals of inventory management and production planning through extensive use of computer media. The game structured around presentation of scenarios and evaluation of decisions made by the users. We intentionally avoid exposing the users to information in a linear fashion. Rather the user's interactions with the game determine which parts of the material are covered at what depth.

The game is modeled after the appliances division of a major consumer electronics and appliances company. This company employs thousands of employees and operates in an international market. It offers TVs, small kitchen appliances, dishwashers, washing machines, etc. We assume that we manufacture only one type of washing machine although in a more realistic setup there would be several types. The game centered on the analysis of the assembly line which operates 50 weeks per year and is expected to produce approximately 12,000 units annually, 240 units weekly. There are 80 retailers; approximately most of them sell 3 units per week. In one week, 0-2 units sell in

the week, and 2-4 units sell in the weekend. The price of the consumer will pay is 1100 TL, retailer buy the same machine at 900 TL.

For instance, there is a financial economy (macro economy) game named "Presidential Game" that uses the learning goal of keeping the national economy healthy. Each year the user should analyze the current state of the economy and choose policies in order to keep the economy on the right track.

Supply Chain diagram below summarizes the operations of our appliance manufacturer. We consider the Wholesaler's inventory according to the Factory, Supplier and the Demand.

Figure 5.1 : Supply Chain Diagram

WashMac game aims i) to help students enjoy learning and improve their performance in the course, and ii) to help students better understand the transition from real life systems to mathematical models. For instance, we can think that, the refrigerator is our inventory and we can decide that when we order or place our material requirements with the suppliers.

This game uses animations and videos. In the first section we want to use the dialogues. In our setting visual content is the most useful to support spatial intelligence as students with spatial intelligence is good with pictures. Also the visual learners learn better by graphics or watching. According to the researchers, people do not forget what they saw, that is another reason why we need to use animations.

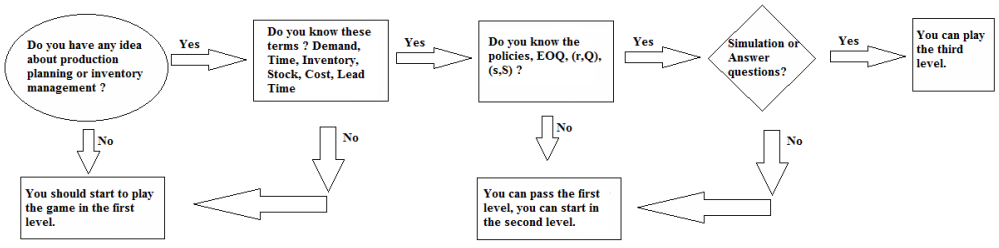
Our game includes 3 levels, first one the easiest, second on is medium, and latest is hard. Users have to play the first level (easy) to level up. In the first (easy) level we assumed that to teach the fundamental terms, like, demand, time, and stock or inventory etc. The second level we want to teach all policies. The hard level, we make some quizzes, some simulations etc. In the second level, first of all, we want to teach EOQ model, so we assumed that the demand

is certain and in the second level the demand is uncertain. Also in the first level we assumed that the backorder costs are too high such that backlogs are not permitted and the lead times are zero. In addition in the first level, the washing machine occurs as just a single item. In the second level the machine occurs as multiple items.

We mentioned that the bill of materials. Specific information and prices are given for selected components.

Quantity	Part Desciption	Manufacturer	Retailer Price
1	Hybrid IC Module - IGBT Driver	M1	$5,25
1	Printed Circuit Board	M2	$0,78
1	MCU - 16bit	M3	$2,89
2	Relay	M4	$2,82
1	Capacitor, 200 V	M5	$2,12
1	Digital Signal Controller	M6	$1,54
1	Wiew Harness	M7	$1,51
1	Heatsink	M8	$1,39
1	Pin Headers	M9	$1,04
	Other Material Costs		$12,69
	Total Bill of Materials Cost		$32,03

We start to teach the basic level, what the demand is, or what the time is, the reason why this program is chosen. We can use this diagram to decide the start level.



In the future work, when someone writes the code of this program, the competitions will be added. There will be some roles, users will play online, similar with beer game. Someone will be retailer role, someone get distributor role etc.

5.1 Welcome Screen

This is the welcome screen. When user clicks the play button, then the next picture will appear. User should choose the level, before click the play button.

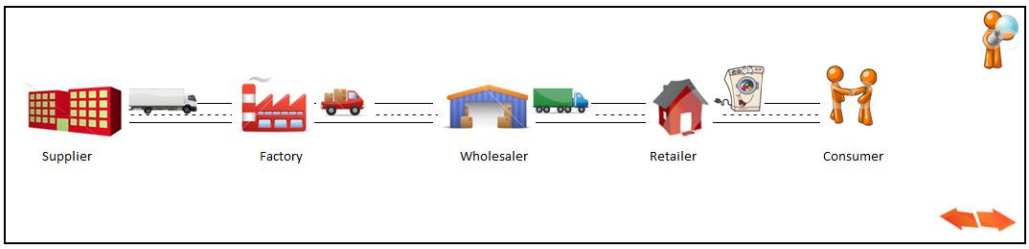
Game Rules button, the pop up opens and listed the rules of the game. Rules are the following:

> User should select a level. If user is beginner so, they have to select the first, easy level.
> User should decide when an order should be placed.
> In the first level, we assume that there is no backorders, lead time is zero, and the demand the certain. In subsequent levels, there are backorders; lead time is different in every stage; also the demand is uncertain.
> Users are provided helpful hints and clues when they want by clicking on the man with the light bulb on the right side of the screen.
> There are some graphics on the screen; user should analyze the orders and sales.

After the level selection user clicks the Play button and the game starts. In the game, there is a man with a bulb in the right side of the screen for users who want to some clues, or help. When the user click the next arrow, then screen will be forward, also users can return the back screens with back arrow. Also

user can give an order any time with clicking an “Order” button. The user can follow cash position and the inventory level through the weeks.

The second screen shows the supply chain: Supplier, Factory, Wholesaler, Retailer and the Consumer. It will animate and a white truck will go to the factory. In the factory, the products will drop from white truck and red truck will pick up the washing machines and goes to the wholesaler. The same thing will be in the wholesaler, and washing machines are dropped to the retailer.



This is the second screen, when user clicks the next button, we will start to teach the fundamental terms.

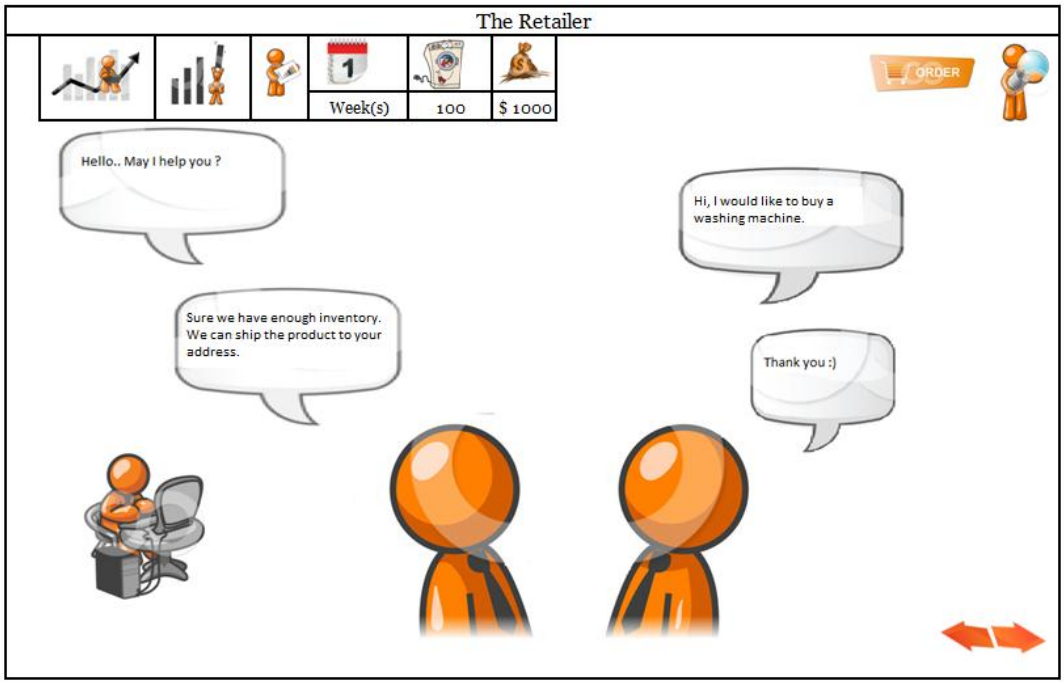
5.2 First Level (Easy)

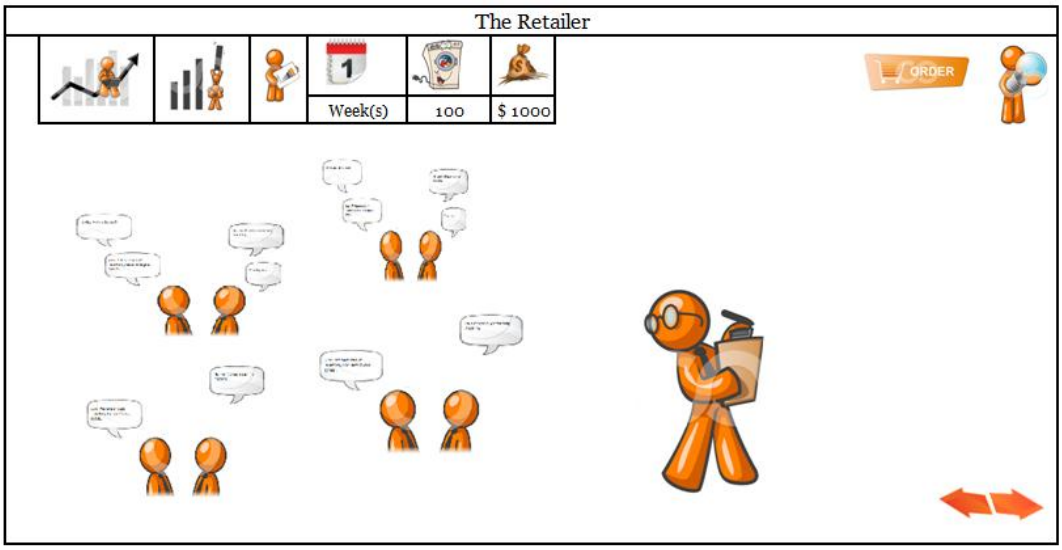
5.2.1 Terms

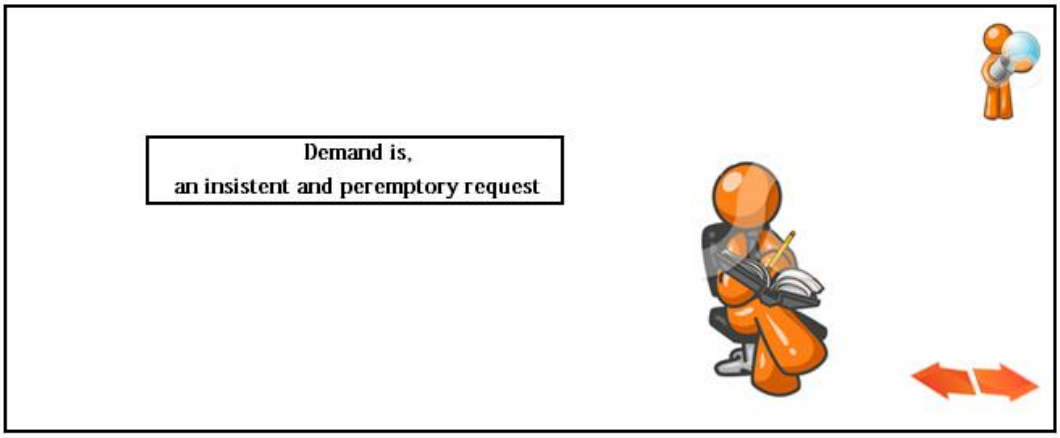
First of all we show the diagram to the students. In this level we will teach the demand, time, inventory, lead time. When the students click the next arrow, then the program zooms in to the retailer. We can see the dialog between the consumer and retailer.

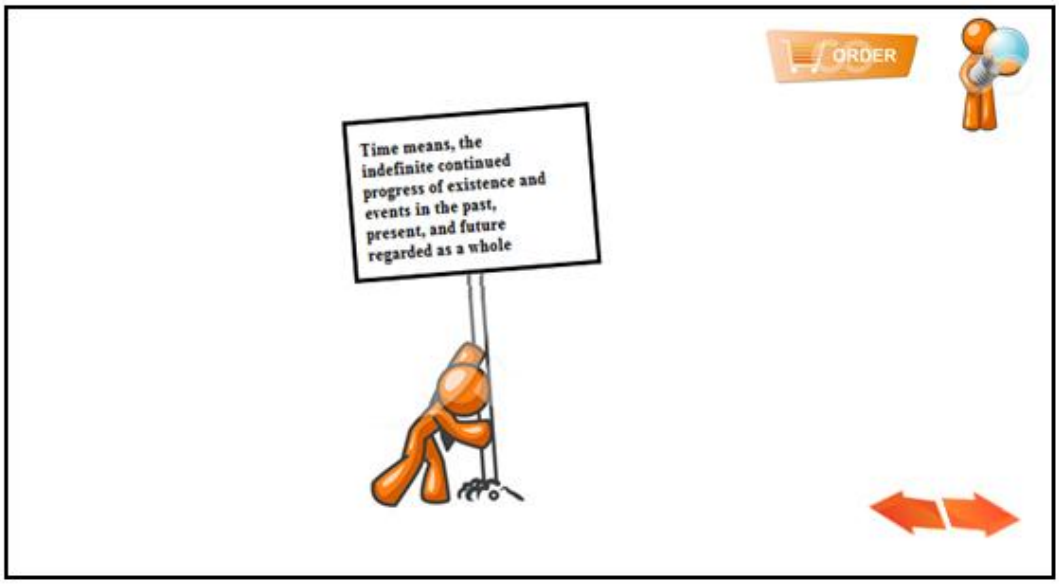
This consumer wants to buy a washing machine. Then the retailer goes to his desk and checks their inventory. He sells a washing machine to this customer. We teach the demand with this dialog.

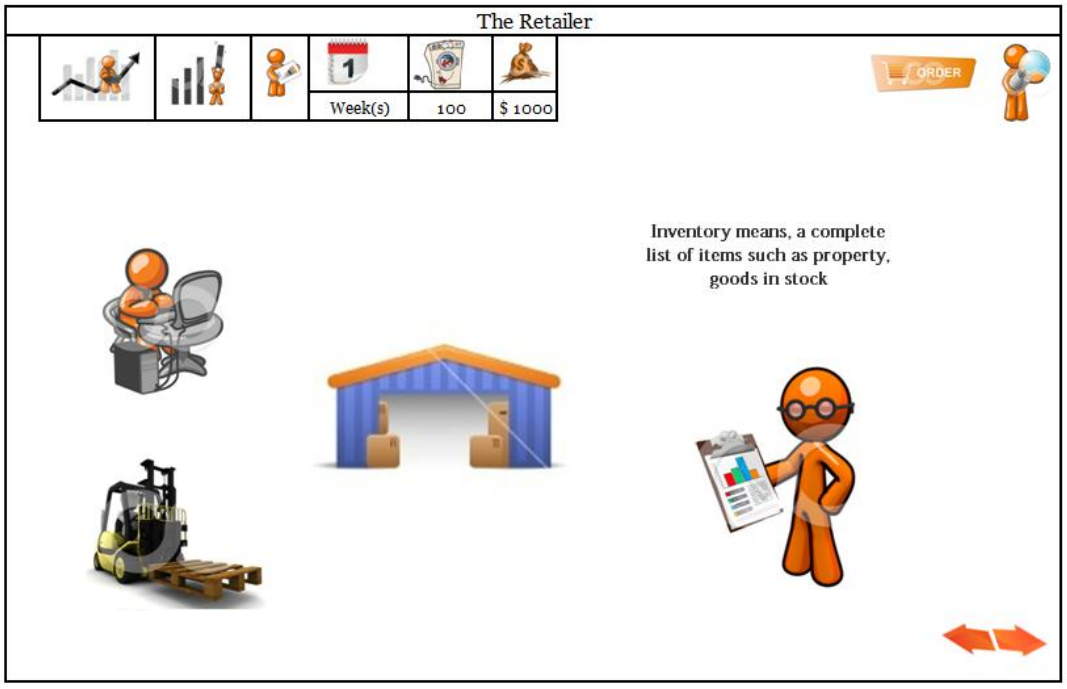
When we teach the time, there order will come in 5 seconds, if the stock is 100 units and user waits 4 minutes then the stock out and the game is over. User should understand the term of time.

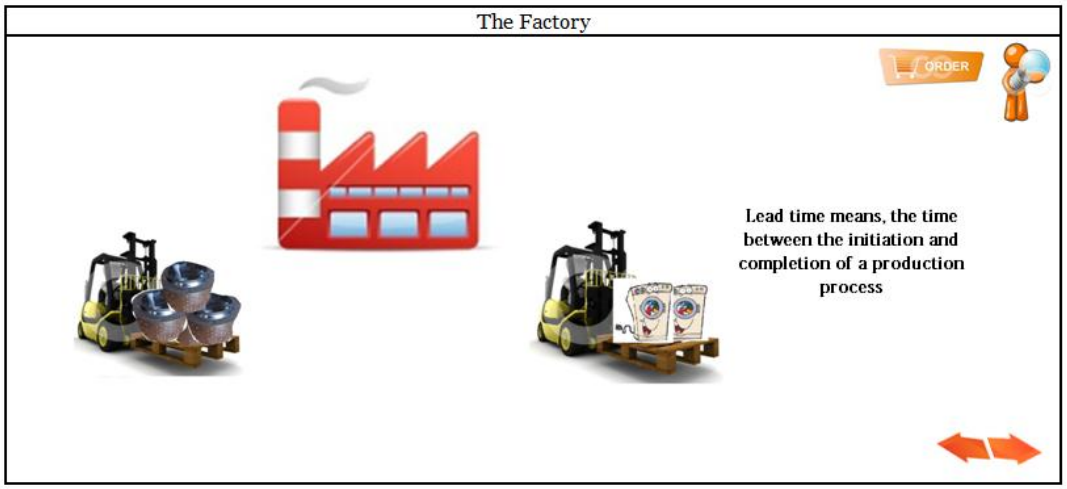

The Retailer
Week(s)
100
$ 1000
ORDER
Hello.. May I help you ?
Hi, I would like to buy a washing machine.
Sure we have enough inventory. We can ship the product to your address.
Thank you :)


The Retailer
Week(s)
100
$ 1000
ORDER


Demand is,
an insistent and peremptory request


ORDER
Time means, the indefinite continued progress of existence and events in the past, present, and future regarded as a whole


The Retailer
1
Week(s)
100
$ 1000
ORDER
Inventory means, a complete list of items such as property, goods in stock

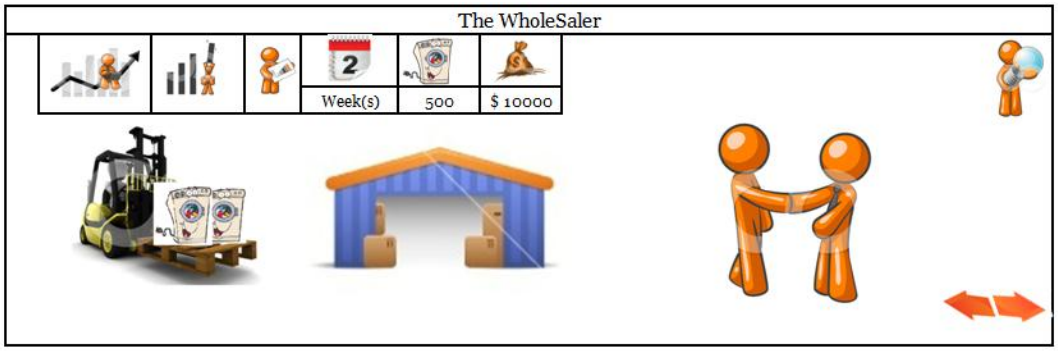

The Factory
ORDER
Lead time means, the time between the initiation and completion of a production process

When user clicks the next arrow, then the first level is finished.

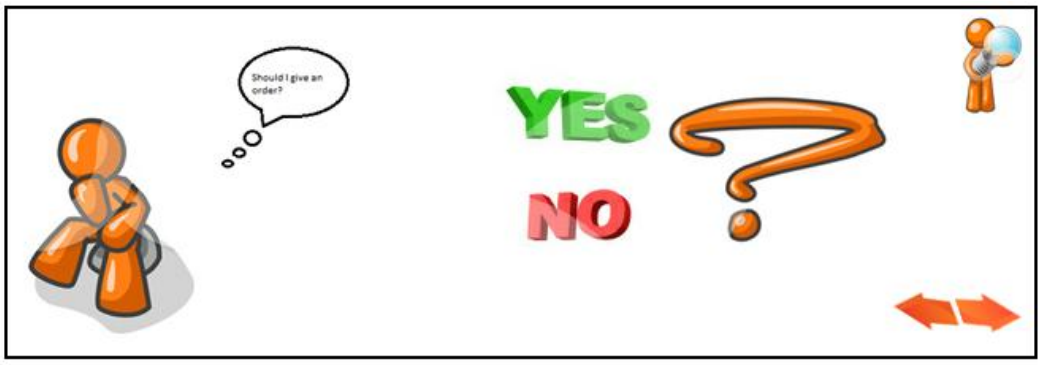
5.3 The Second Level (Medium)

We taught the fundamental terms and now we can teach the policies, first of all we start with EOQ Model. We assume that the demand is certain, there is no backorders, and lead time is zero. Also the washing machine has occurs in single item, which is drum.

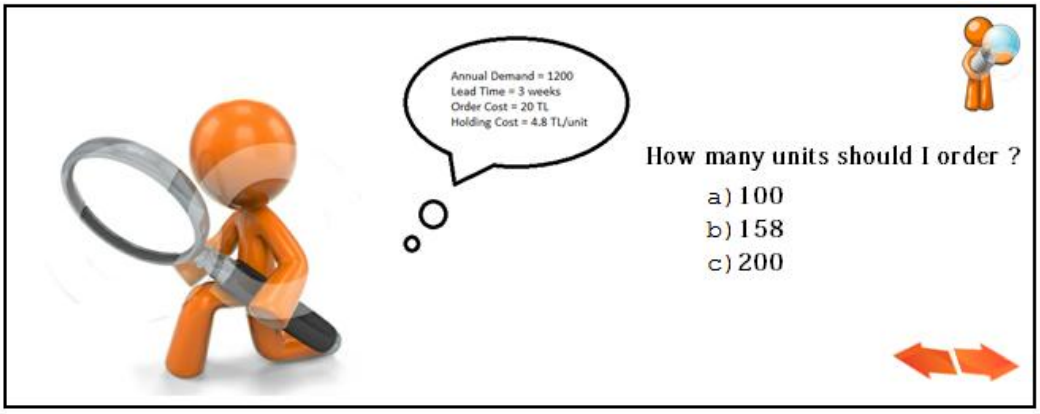
5.3.1 EOQ Model



All retailers (80 retailers) want 240 washing machines for a week. The inventory of the wholesaler became 500. Than we forced to think, is this inventory enough? “Should you give an order now?”



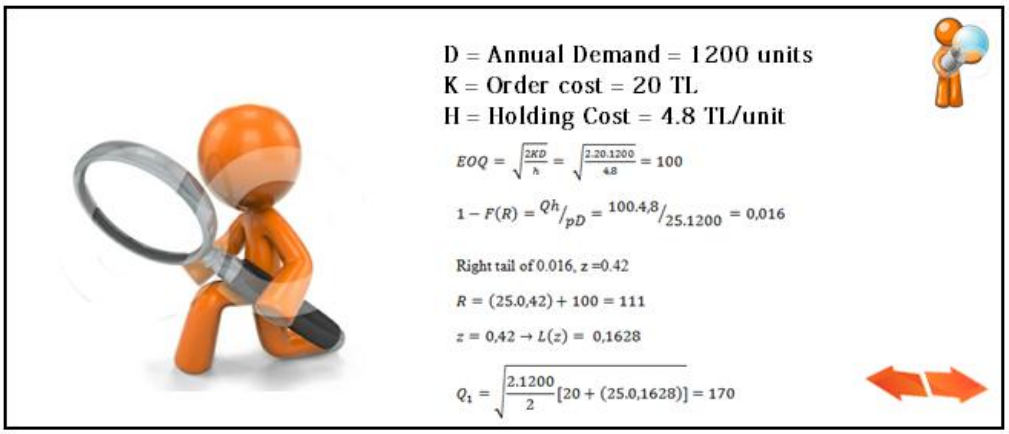
If user clicks the Yes button, then the second screen will appear.



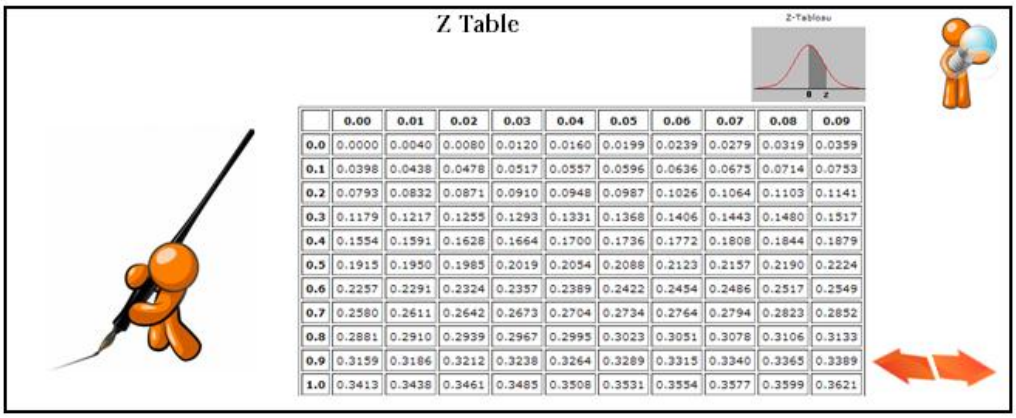
The right answer is 158, if user selects b, then,

If user select a or c, then

When user clicks to the show the solution; this is the first part of the solution;

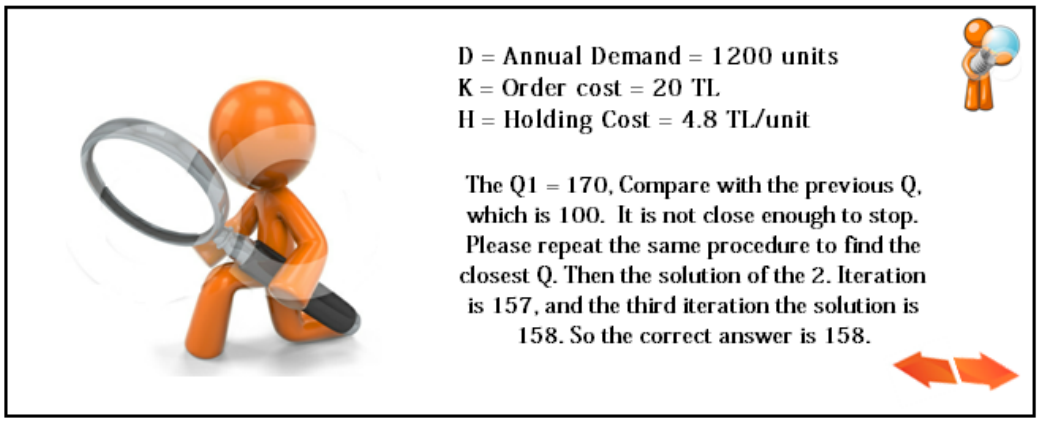


Z table is,

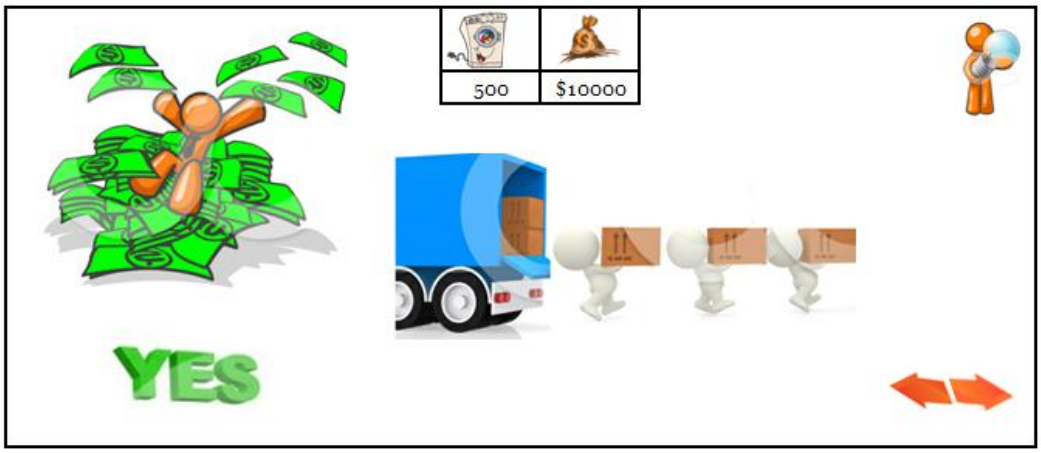


	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621

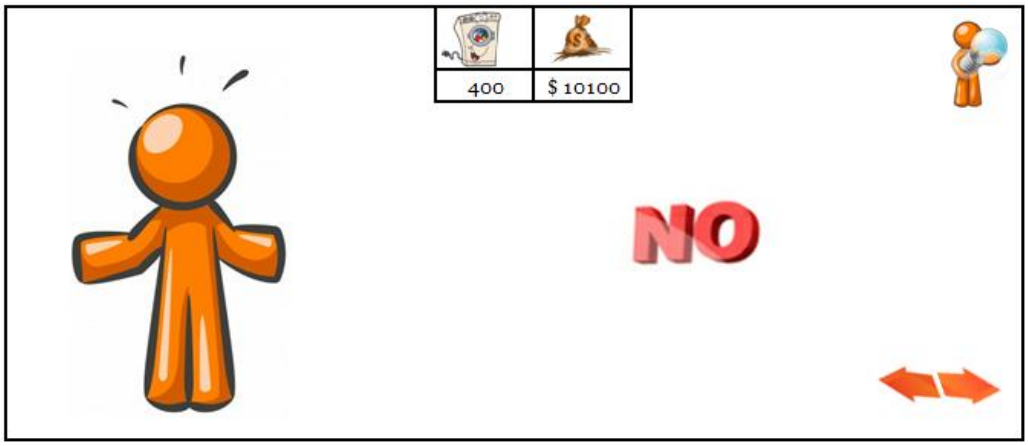
Second part is,



The wholesalers inventory increases. And people who are carrying the boxes will move.

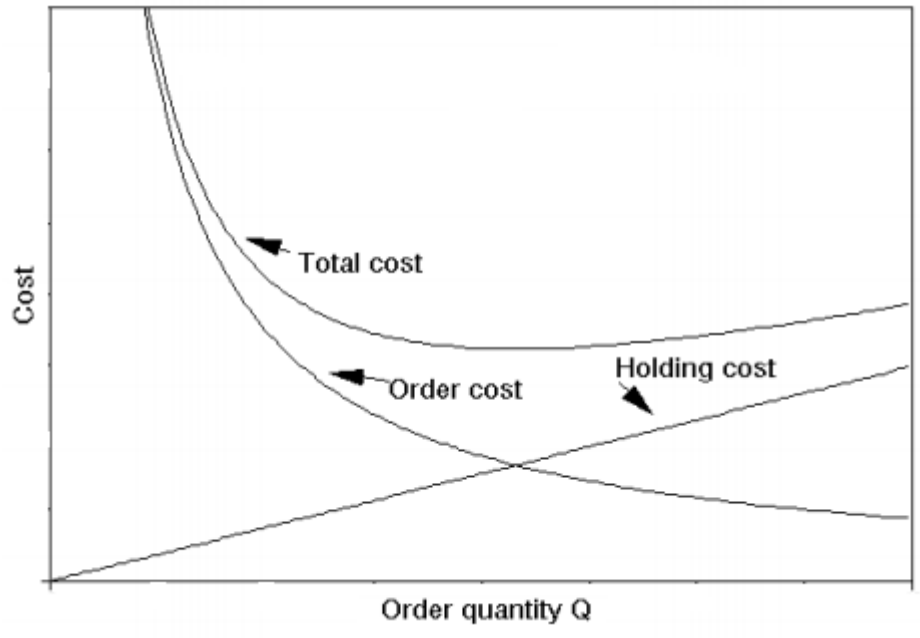


If users select No, the following screen will come.



When user selects no and when the inventory became zero, then the game is over, and user starts it again.

We assume that user selects “Yes”, then the next screen will appear.



The formula is the following.

$$Q = \sqrt{\frac{2DK}{H}}$$

Q = Order quantity

D = Annual demand

K = Order cost

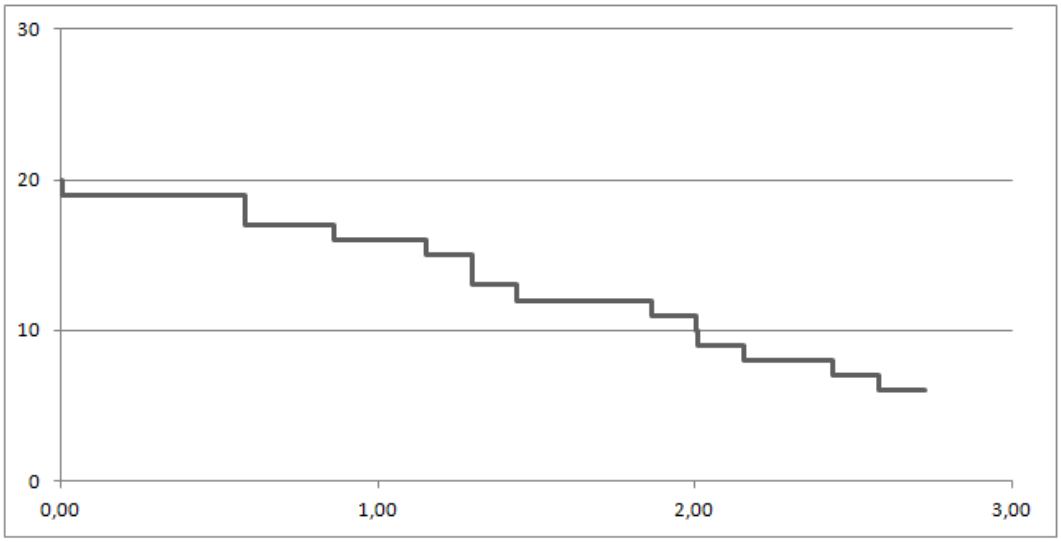
C = Cost / item

H = Holding Cost

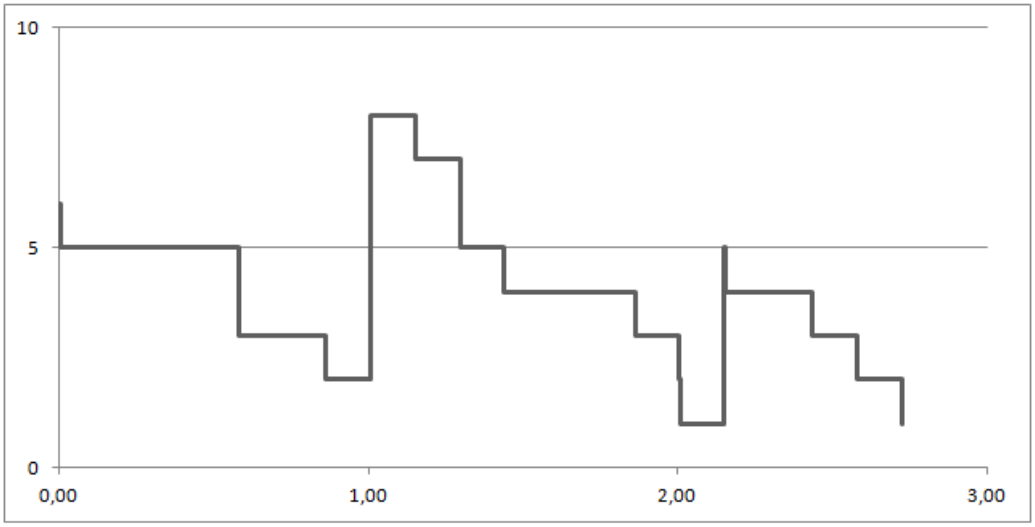
The sales in a week is the following, we draw the inventory graph according to these data.

Retailer 1					
Week	Day	Time (hr)	Time	Sell	Total
1	April 12, 2010	10:00	0,00	--	--
1	April 12, 2010	13:00	0,54	1	3
1	April 17, 2010	16:00	48,67	1	
1	April 17, 2010	20:30	48,85	1	
2	April 20, 2010	11:30	72,48	1	4
2	April 22, 2010	14:00	96,58	1	
2	April 23, 2010	19:30	108,81	1	
2	April 23, 2010	21:00	108,88	1	
3	April 26, 2010	15:00	120,63	1	2
3	April 29, 2010	17:00	156,71	1	
4	May 2, 2010	10:30	168,44	1	6
4	May 2, 2010	14:30	168,60	1	
4	May 3, 2010	21:30	180,90	1	
4	May 5, 2010	10:00	204,42	1	
4	May 6, 2010	16:30	216,69	1	
4	May 8, 2010	18:00	228,75	1	

When user click the graphics icons, there will open variable graphics. We assume that there is no replenishment.



If we allowed the replenishment with the same data, than the inventory graph will be the following.

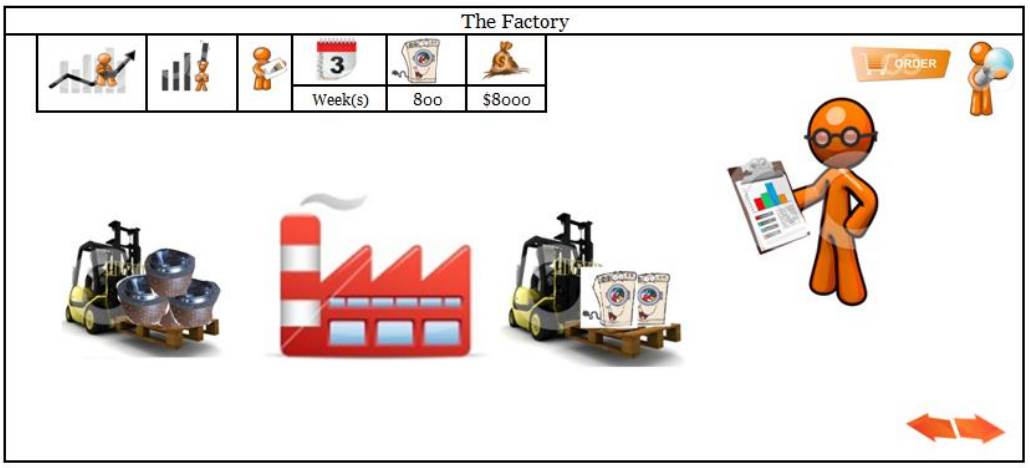


Then zoom out from the wholesaler and zoom in the factory.

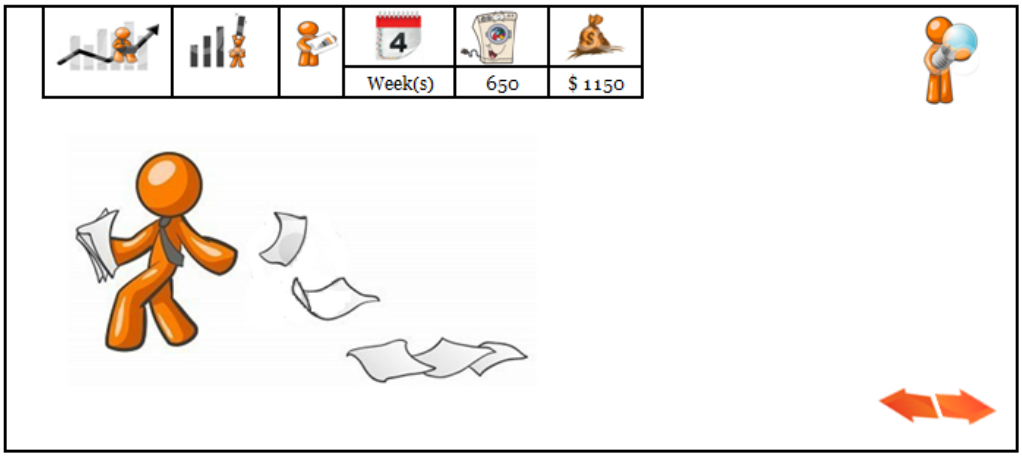
5.3.2 (r,Q), (s,S) Policies

In the 3rd week, the factory's inventory is 800 washing machines. Their cash position is $8,000. The demand from the wholesaler is 240 units in a week.

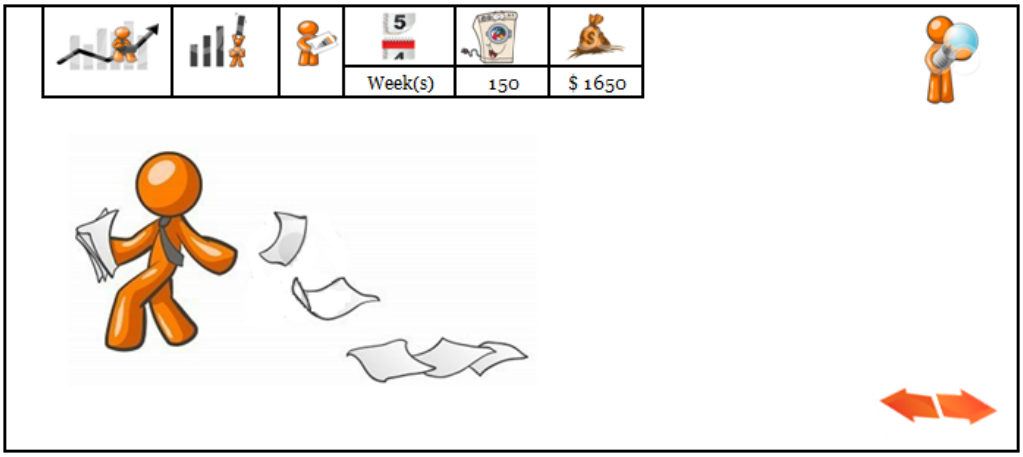
We assume that the washing machine is occurs with multi items, which are drum and resistance. We will use the (r,Q) continuous review inventory control policy. The demand is deterministic and backorders are allowed.



The inventory will decrease in a couple of weeks later.

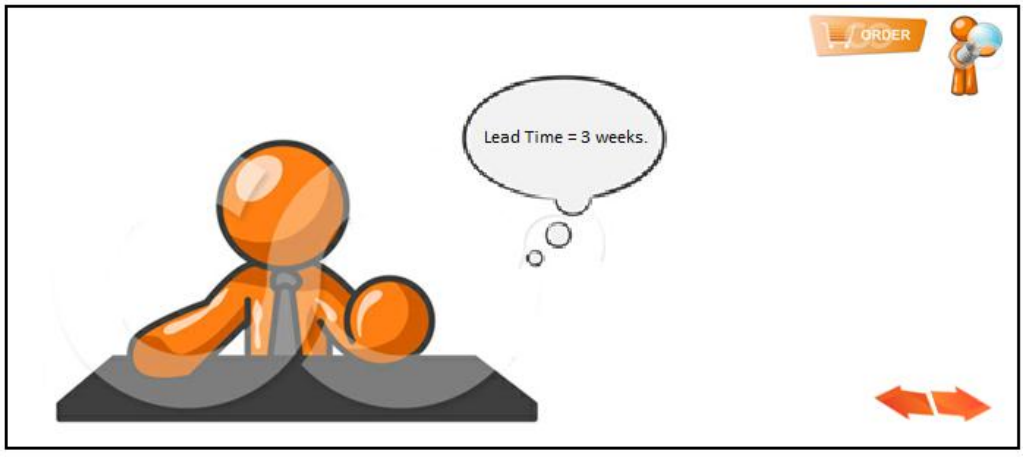


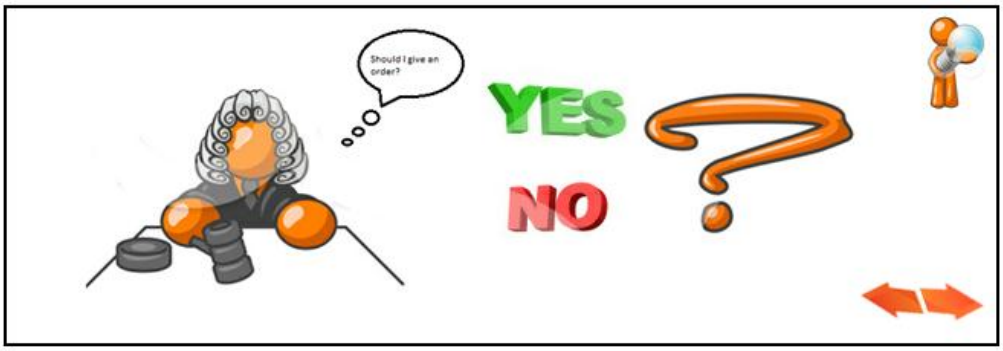
Weeks will change.



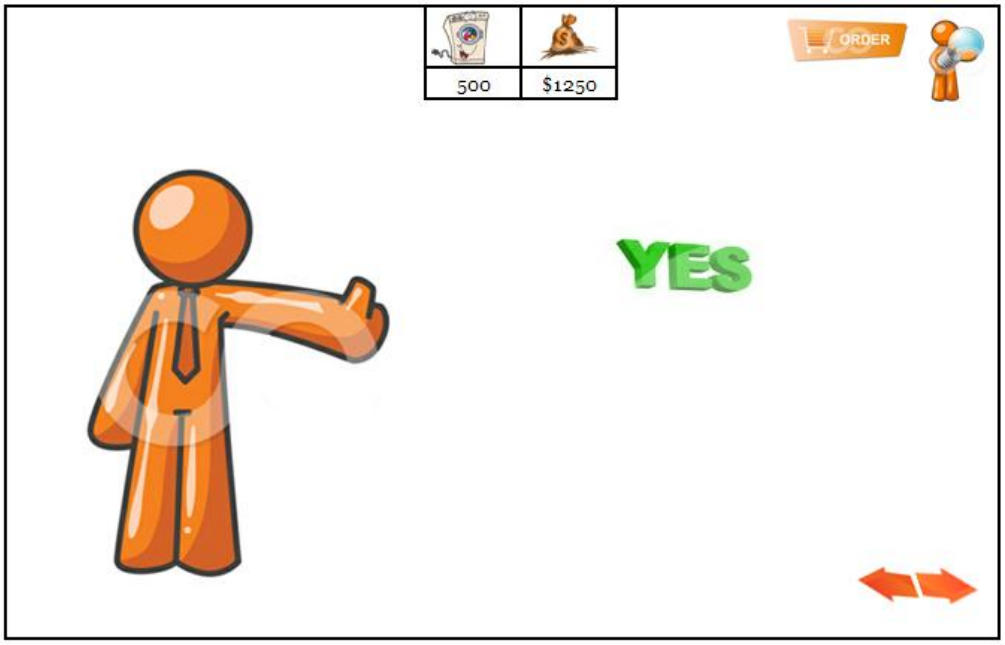
User decides when the orders should give? There is a question appears.

The lead time is 3 weeks.



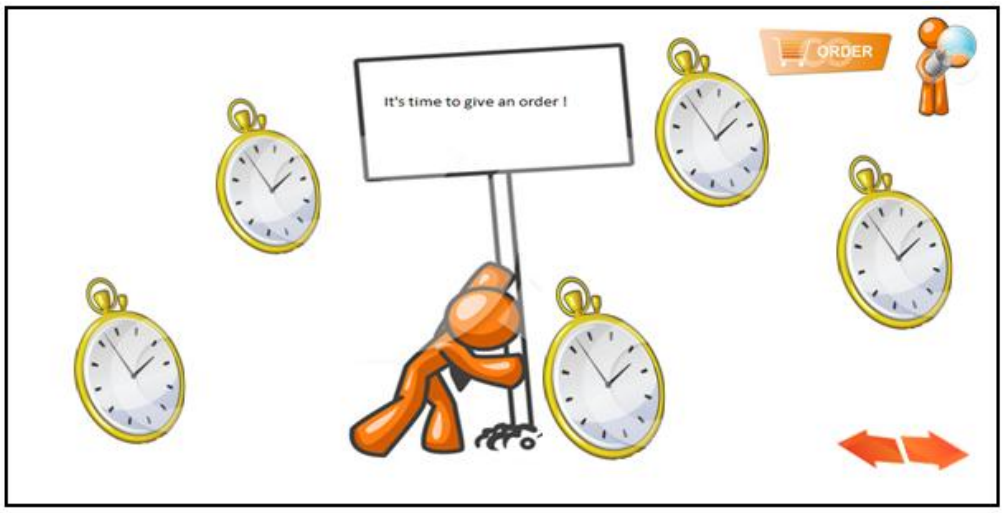


If user select yes than, the inventory will increase up to 1040.



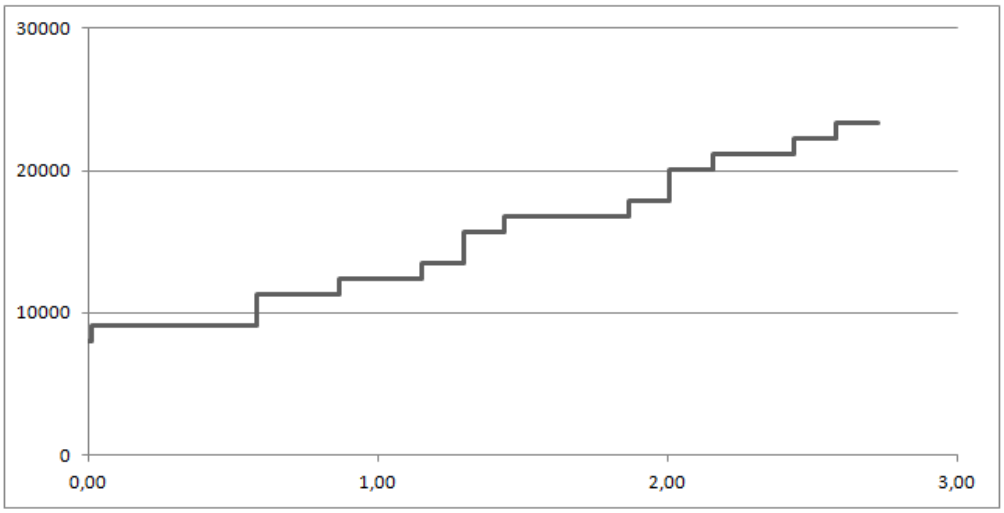
If user selects No, then the inventory will drop to 560.

And now, user should give an order after to the next screen.

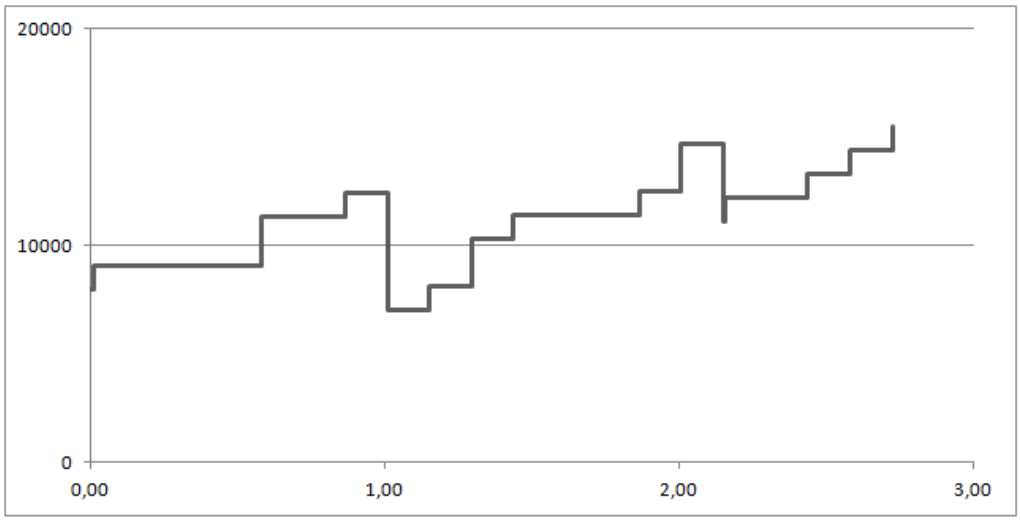


Then zoom out from the factor and zoom in the supplier.

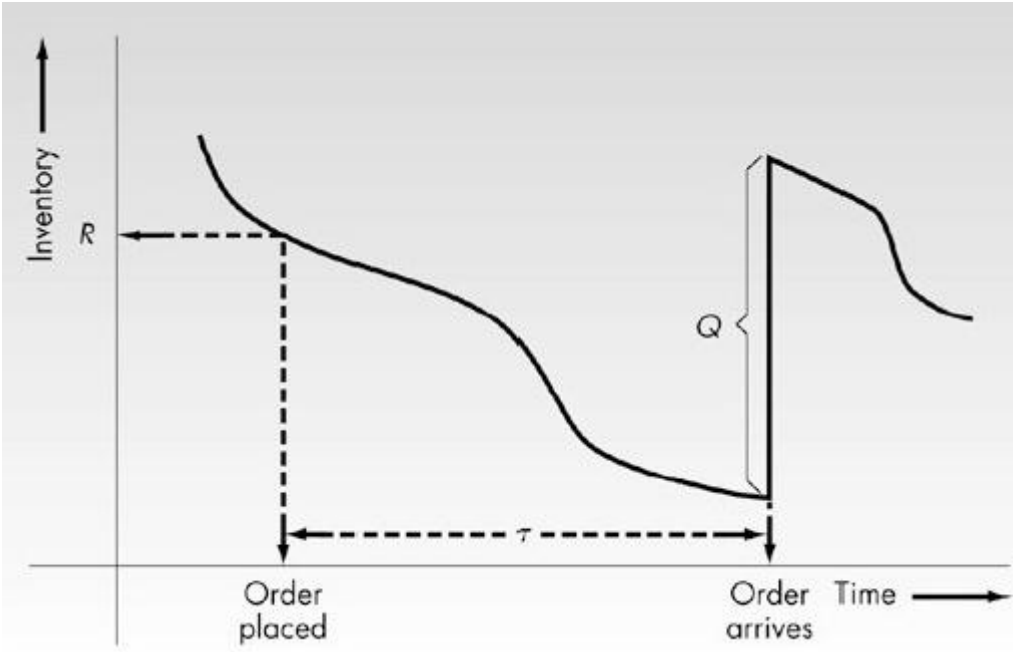
First of the second graph button will flash. This is the cash graphic according to the same data. We assume that there is no replenishment.



If we allowed the replenishment with the same data, than the cash graph will be the following.



If user clicks the first graph, then the screen will show up. The time trajectory of inventory controlled according to the (r,Q) continuous review policy is shown. The inventory will decreases with each purchase and is replenished as each order arrives.



The formula of this graph is the following:

$$G(r,Q) = \underset{\text{Cost}}{\text{Holding}} + \underset{\text{Cost}}{\text{Order}} + \underset{\text{Cost}}{\text{Shortage}}$$
$$= h\left(\frac{Q}{2} + r - D\tau\right) + K\frac{D}{Q} + P\frac{Dn(r)}{Q}$$

The notations are the following:

K: Ordering Cost

H: Holding Cost

C: Cost/item

P: shortage cost

The equation of the problem is:

$$EOQ = \sqrt{\frac{2KD}{H}} = \sqrt{\frac{2.20.1200}{4{,}8}} = 100$$

$$1 - F(R) = {}^{QH}/_{pD} = {}^{100.4{,}8}/_{25.1200} = 0{,}016$$

Right tail of 0.016, z =0.42

$$R = (25.0{,}42) + 100 = 111$$

$$z = 0{,}42 \rightarrow L(z) = 0{,}1628$$

$$Q_1 = \sqrt{\frac{2.1200}{2}[20 + (25.0{,}1628)]} = 170$$

We compare with the previous Q, which is 100. It is not close enough to stop. We repeat the same procedure to find the closest Q. Then we calculate the 2. Iteration we found 157, and the third iteration we found 158. So the correct answer is, 158.

Then order button will flash.

Then zoom out from the wholesaler and zoom in the factory.

We manage two components of the washing machine: drum and resistance. We will use the (s,S) model. The demand is uncertain and backorders are allowed. In this level, there is a simulation. User decides the amount of the order and also decides the weeks. For example, the production will start when the amount decrease to 100 units. When the amount becomes 100, produce up to 200. How many weeks, this production will continue. User will decide the how many weeks will continue, for example 50 weeks.

5.4 The Third Level (Hard)

5.4.1 Quizzes

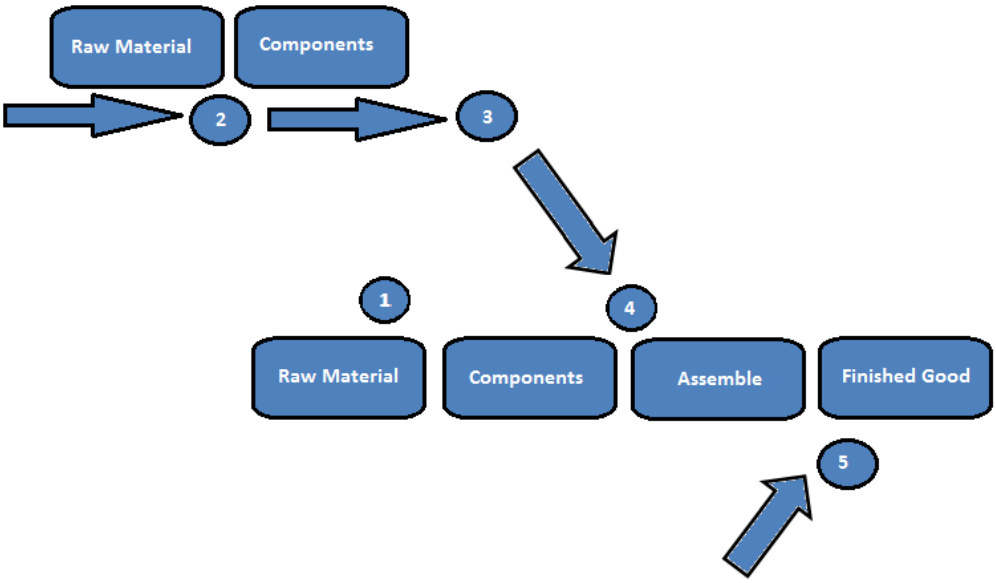
When user comes to the final level, there will be some questions.

We want the user solves the EOQ, and other policies. We will give some parameters and we want the user to calculate.

We ask some multiple choices questions, something like, “What is lead time?” etc.

5.4.2 Assembly Line

Raw material became a component; some components come together and after the assembly than they became semi-good, or finish good. Semi or finish good comes together in the other assembly line. In this picture, we can give a part of the assembly line.


Raw Material
Components
2
3
1
4
Raw Material
Components
Assemble
Finished Good
5

Chapter 6
Conclusion

In this project, we built an interface about the implementation because all students want to enjoy while learning. New technologies are introduced at a rapid rate and young people especially college students adopt them at the same pace. This raises the expectations of students from courses, instructors, and teaching medium. We can expect that the teaching methods will evolve to match with new learning styles. While we were developing this interface we benefit from the learning theories. Spatial intelligence and body intelligence which are the main theories that guided in our project. Most people learn the most efficiently with pictures and/or by doing rather than pure listening.

We prefer the subject of inventory management, so students will learn how the demand, inventory will change in limited time.

In this project, I learned that, the learning theories and also analyzing is the most important part of the program. This program teaches the all policies about the inventory management.
I have not enough programming knowledge, so we couldn't write the program.
In the future work, when someone writes the code of this program, the competitions will be added.
There will be some roles, users will play online, similar with beer game.
Someone will be retailer role, someone get distributor role etc.
This game is generally about the spatial intelligence. There some frameworks, for instance, drupal, joomla etc. this program will be played.

Curriculum Vitae

Zeynep Kaplan was born in İzmit on 28 April 1986. She received her BS degree in Industrial Engineering in 2009 from Işık University. She is currently a student of the in Economics and Management at Anadolu University. She has been working as an analyst at Application Development-Corporate Credits Department at ING Bank since 2010. She is working on Corporate Credits. She is a congress member of the Beşiktaş Jimnastik Kulübü.

References

[1] http://www.learning-styles-online.com/overview/ website.

[2] http://en.wikipedia.org/wiki/Classical_education_movement website.

[3] http://www.termpaperwarehouse.com/essay-on/Use-Of-Computer-Aided-Instruction-In/114107 website.

[4] http://www.writework.com/essay/learning-permanent-change-behaviour-caused-experience-lear website

[5] http://www.dynamicflight.com/avcfibook/learning_process/ website.

[6] http://howwelearn.weebly.com/learning-styles.html website

[7] http://www.montgomerycollege.edu/Departments/studevgt/onlinsts/Resources/DSsite/ learningstyles.htm website

[8] http://www.quotationspage.com/quote/25848.html website

[9] http://en.wikipedia.org/wiki/Edward_Thorndike website.

[10] http://www.simplypsychology.org/edward-thorndike.html website.

[11] http://en.wikipedia.org/wiki/Ivan_Pavlov website

[12] http://www.nobelprize.org/nobel_prizes/medicine/laureates/1904/pavlov-bio.html website

[13] http://www.simplypsychology.org/pavlov.html website.

[14] http://en.wikipedia.org/wiki/John_B._Watson website

[15] http://www.simplypsychology.org/classical-conditioning.html website

[16] http://en.wikipedia.org/wiki/B._F._Skinner website

[17] http://www.bfskinner.org/bfskinner/Home.html website

[18] http://www.simplypsychology.org/operant-conditioning.html website

[19] http://en.wikipedia.org/wiki/Albert_Bandura website

[20] Bandura, A. (1975). Social Learning & Personality Development: Holt, Rinehart & Winston, INC: NJ.

[21] Evans, R.I. (1989). Albert Bandura: The Man and His Ideas---A Dialogue. New York: Praeger

[22]http://skyview.vansd.org/lschmidt/Projects/The%20Nine%20Types%20of%20 Intelligence.htm website.

[23]http://www.macalester.edu/academics/psychology/whathap/ubnrp/intelligence05/ mtypes.html website

[24] http://www.learningrx.com/types-of-learning-styles-faq.htm website.

[25] http://www.washington.edu/doit/TeamN/types.html website.

[26] http://en.wikipedia.org/wiki/Bloom's_Taxonomy website

[27]http://www.nwlink.com/~donclark/hrd/bloom.html website.

[28] R.M. Felder and J.E. Spurlin, "Applications, Reliability, and Validity of the Index of Learning Styles." Intl. Journal of Engineering Education, 21(1), 103-112 (2005). A validation study of the Index of Learning Styles.

[29] http://en.wikipedia.org/wiki/Traditional_education website

[30] http://en.wikipedia.org/wiki/E-learning website.

[31] http://www.educause.edu/ero/article/asynchronous-and-synchronous-e-learning website.

[32] http://en.wikipedia.org/wiki/Project-based_learning website.

[33]http://www.ascd.org/publications/educational_leadership/sept10/vol68/num01/ Seven_Essentials_for_Project-Based_Learning.aspx website

[34] http://www.engines4ed.org/hyperbook/nodes/NODE-120-pg.html website

[35] http://en.wikipedia.org/wiki/Learning-by-doing_(economics) website

[36] http://newlearningonline.com/ website

[37] http://www.newlearninginstitute.org/ website

[38] http://www.schoolsnet.com/uk-schools/schoolHome.jsp website

[39] http://www.new-oceans.co.uk/new/learn.htm website

[40] www.proquestk12.com/pic/pdfs/eLibraryUserGuide.doc documentations

[41] http://www.teachersource.com/ website

[42] http://www.mathgoodies.com/ website

[43] http://www.ascilite.org.au/conferences/coffs00/papers/albert_ip.pdf

[45] http://tep.uoregon.edu/resources/assessment/learningobjectives.html website

[46] http://www.nottingham.ac.uk/medical-school/tips/aims_objectives.html website.

[47] http://www.explearning.ucf.edu/categories/for%20students/co-op_and_internships/registered_students/tips_for_success/195_152.aspx website

[48] http://usagso-sg.tripod.com/22_learning_objectives.pdf website

[49] http://www.socialmarketing.org/newsletter/features/generation3.htm website

[50] http://en.wikipedia.org/wiki/Generation_Z website

[51] http://en.wikipedia.org/wiki/Industrial_engineering website

[52] http://www.ielassoc.org/ website

[53] S. Uchida, N. Yamaki, “Visual Matrix Calculator For Undergraduate Students”, *Elsevier Science* 1999, (pp. 309-312)

[54] J.Hanc, S. Lukac, J. Sekerak and D.Sveda, “Geogebra – A Complex Digital Tool For Highly Effective Math And Science Teaching”, *IEEE – ICETA October 27-28 - 2011.*

[55] H.Y.K Lau, K.L. Mak, “The Virtual Company: A Re-Configurable Open Shell For Problem Based Learning In Industrial Engineering”, *Elsevier Science* 2004, (pp. 289-312)

[56] M. Khan, S. Akhtar, “Supply Chain Simulator: A Scenario-Based Educational Tool to Enhance Student Learning”, *Science Direct* 2008, (pp. 252-261)

[57] James F. Cox, Edward D. Walker, “The Poker Chip Game: A Multi-Product, Multi-Customer, Multi Echelon, Stochastic Supply Chain Network Useful For Teaching The Impacts Of Pull Versus Push Inventory Policies On Link And Chain Performance”, *Interfaces* 6:3 (pp. 3-19)

[58] http://en.wikipedia.org/wiki/Sharable_Content_Object_Reference_Model

[59] http://scorm.com/scorm-explained/

[60] http://www.beergame.lim.ethz.ch/ website.

[61] Peter M. Senge, "Beşinci Disiplin", Yapı Kredi Yayınları

[62] http://itersnews.com/?p=7833 website.

[63] http://en.wikipedia.org/wiki/Prisoner's_dilemma website.