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DESIGN AND IMPLEMENTATION OF MOBILE BASED GAMIFIED
LEARNING MANAGEMENT SYSTEM TO IMPROVE LEARNING INTEREST
OF ARCHITECTURE STUDENTS

THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF ATILIM UNIVERSITY

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LEARNING MANAGEMENT SYSTEM TO IMPROVE LEARNING INTEREST
OF ARCHITECTURE STUDENTS

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ABSTRACT

DESIGN AND IMPLEMENTATION OF MOBILE BASED GAMIFIED LEARNING MANAGEMENT SYSTEM TO IMPROVE LEARNING INTEREST OF ARCHITECTURE STUDENTS

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With ever increasing interest in modern digital technologies and utilizations, stakeholders in academic industries are shifting attention to modern available tools that can promote convenient learning processes for students. Gamified learning is defined as act of learning system that utilizes game based mechanics and elements to enhance academic learning in non-gaming context. The aim of this study is to design and implement a mobile based gamified learning Management system to improve learning interest of architecture students at the university. In the study problems have been identified through collection of series of data pertaining to student learning techniques and outcome via hosted survey form. Data collected were analysed to identify problem areas before coming out with mobile application development solution to offer improvement to learning interest of students. This experimental study is based on gamified learning. Chi-Square test used to test dependent and in-dependent variables on gamified learning systems as analysing method. According to the Pre-test and Post-test survey results showed that gamified learning can be used to motivate students, increase engagement levels and ultimately improve their overall learning outcomes.

Keywords: Gamification, Active Learning, Collaborative learning, Problem Solving, Architecture Education

ÖZ

MİMARLIK ÖĞRENCİLERİNİN ÖĞRENME İLGİLERİNİ ARTIRMAK İÇİN MOBİL TABANLI OYUNLANDIRILMIŞ ÖĞRENME YÖNETİM SİSTEMİNİN TASARLANMASI VE UYGULANMASI

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Günümüzde modern dijital teknolojilere ve kullanımlara giderek artan ilgi sebebi ile yapılan akademik araştırmalar da dikkatlerini öğrenciler için uygun öğrenme süreçlerini teşvik edebilecek mevcut modern araçlara kaydırıyor. Oyunlaştırılmış öğrenme, akademik öğrenmeyi geliştirmek için oyun tabanlı mekaniği ve öğeleri kullanan öğrenme eylemi olarak tanımlanmaktadır. Bu çalışmanın amacı mobil tabanlı oyunlaştırılmış bir öğrenme ortamı tasarlayarak mimarlık öğrencilerinin eğitimlerini daha ilgi çekici bir hale getirmektir.

Geliştirilen uygulama üniversitedeki mimarlık öğrencilerinin öğrenme ilgilerini artırmaya yönelik bir yönetim sistemidir. Çalışmada, barındırılan anket formu aracılığıyla öğrenci öğrenme teknikleri ve çıktılarına ilişkin bir dizi veri toplanarak sorunlar belirlenmiştir. Toplanan veriler, öğrencilerin öğrenme ilgilerini artırmak için mobil uygulama geliştirme çözümü ortaya çıkmadan önce sorunlu alanları belirlemek için analiz edilmiştir. Bu deneysel çalışma, oyunlaştırılmış öğrenme üzerine kuruludur. Analiz yöntemi olarak oyunlaştırılmış öğrenme sistemlerinde bağımlı ve bağımsız değişkenleri test etmek için Ki-Kare testi kullanılmıştır. Ön test ve Son test anket sonuçları, oyunlaştırılmış öğrenmenin öğrencileri motive etmek, katılım düzeylerini artırmak ve nihayetinde genel öğrenme çıktılarını iyileştirmek için kullanılabilirliğini göstermiştir.

Anahtar Kelimeler: Oyunlaştırma, Aktif Öğrenme, İşbirlikli öğrenme, Problem Çözme, Mimarlık Eğitimi

DEDICATION

Research in this report is devoted to Almighty God for His unending mercies, gift-of-life and love bestowed on me throughout my project period and study at ATILIM University, Turkey

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Gamified learning is defined as act of learning system that utilizes game based mechanics and elements to enhance academic learning in non-gaming context [1]. It is application of gaming techniques needed to boost and improve individual learning capacity in more fascinating manners. Game has ever known to transmit lifelong skills that are useful in problem-solving, social awareness, critical thinking and human collaboration to man which helps in boosting individual motivation and cognitive ability towards certain academic subjects by minimizing attrition rate among learners that may lead to improving learning interest. According to [2], gamified learning influences human's behaviour by triggering release of dopamine brain-chemical that makes each player feels relax, motivated and in good mood to learn. It offers many advantages over conventional learning system by increasing motivational level of learners, boosting knowledge retention and engagement via awarding of points, badges and leader-boards for academic improvement purposes. It remains important strategy employed worldwide by contemporary teachers to impact learning on students for improved academic brilliant performances through creation of emotional bond between student and academic resources as in Figure 1.1 below:



Figure. 1.1: Typical Gamified Learning (Trueeducationpartnerships, 2022)

Gamified learning helps student in retaining and remembering what was learnt in previous classes due to simulation of hippocampal presence in human brain that promotes information storage for long term remembrance purpose. It also helps release of endorphins that are naturally known as painkillers which maintain academic focused learning, calmness and relaxation on given task. Gamification stimulates neuroplasticity which assists human brain to respond fast to different stimuli and creates new bond capable of increasing cognitive skills to improve creativity, problem-solving skill and also prevents cognitive-decline that is related to old-age.

However, architecture is referred to science and art of designing structures, objects and buildings like urban design, town planning and landscaping. It represents manipulation and application of forms, light, shapes and space to change our surrounding; products of architecture is everywhere within environment ranging from schools, offices, houses, supermarkets to religion edifices, hospitals and many more. Architecture requires aesthetic sensibility, sound technical ability and skills in different fields of functional design, engineering, geometry, ergonomics, building techniques and logistics [3]. Qualifying as architect to practice requires long journey of education, examination and internship that demands creativity, dedication and rigorous academic learning pursuit. Learning architecture is daunting task which requires gamification approach and game elements like point scoring, team-work, peer competition and score-tables to help architectural students assimilate, stay focus or acquire new knowledge to proffer solution to learning architecture in fascinating manners. Introduction to basic architectural education needs adequate understanding of traditional and modern academic concepts in spatial reasoning, dynamic system and experiential learning. Within academic architectural education, there has been increase in debate concerning reviewing present academic curriculum to reflect modern concept like virtual design, gamified learning and augmented reality while essential analogue/legacy concept is retained or blended together to have hybrid system. In Fig. 1.2, games mechanics like challenges and reward has been incorporated learning model to improve user learning engagement and organisation productivity and goals.



Figure. 1.2: Learning Model for Gamification Management (Andrew, 2017)

Some gamification concepts like social networking, game design and point value have been introduced into different education environments excluding architecture for long with responses being positive. Introduction to architectural education remains basis of building career for elementary architectural students that always requires cognitive reasoning, experiential learning and dynamic system as one proceeds into advance stage of architecture education. However, gamification of learning promises hope to architectural students through integration of game principles or gamification elements like narrative design, social connection, fun, instant feedback, player control and progress indicator into traditional curriculum for architecture education in order to enable students improve in retention, understanding and engagement that are required to solve complex tasks as they advance in architectural journey.

Learning is methodology employed by tutors to transmit knowledge to end-learner students for future societal impacts in their various domains; it usually involves academic participation and collaboration between tutors and students engaging in learning activities. As we live, go to work, socialize and meet people on daily-basis, policy-makers in academic sectors have started exploring potential advantages of utilizing technology to support education and ease teacher's workload to improve world of architecture through adoption of blended learning. Gamified learning is another form of blended learning which permits academic content delivery using mixture of online and traditional learning system. According to [4]; pointed out how finding showed that blended gamified learning system promoted skill, thinking and

attitudinal development. Blended learning allows multiple mode of learning content delivery system via face-to-face and online learning modes at learner's pace and time. Gamified learning remains best form of blended learning that is suitable for architecture students to improve their academic performances irrespective of locations and time of learning. Online learning takes place via internet/intranet connectivity while offline learning usually takes place within physical classroom buildings. Integration of gamification learning management concept into blended learning will enable students to learn faster, control learning activities and boost motivation as they enjoy playing games to meet learning goals by earning badges and climb up to ladders [5]. Gamification learning management is efficient teaching academic game based strategy that can benefit architectural students to meet contemporary academic benchmark through inclusion of game elements and motivations into curriculum that should be encouraged to improve academic learning interest of ATILIM University architectural students.

1.2 Statement of Problem

Education is important component of any human society that are living and working harmoniously to learn and grow. Before internet came into existence, traditional learning system was major essential form of global education that was widely accepted for architectural students and other field of studies. However, it was discovered to contain lots of irregularities that demand academic adjustment to fit contemporary digital environment in term of quality education delivery for modern architecture students and practice. Today, many architectural institutions including ATILIM University base their teachings and learning of modern architecture on outdated content delivery methodologies. Data collected through survey form hosted as document in Google server at docs.google.com for respondents to fill and submit as well as data processing revealed how many things are wrong with conventional legacy classroom learning system which requires to be adjusted to fit needs of modern students that are used to engaging in computer games, entertainment and sport betting. Traditional based classroom education always fail to achieve expected/target result due to poor technique of content delivery to architectural students and unexpected natural occurrences that may affect/disrupt student and

learning like, traffic-jam, illness, inability to meet learning target and accumulated stress.

Many other traditional learning challenges facing architectural mode of education are:

- i. Architectural students waste useful and beneficial times in traditional classroom environment waiting for lecturer/tutor to first mark student attendance, make academic announcement or pause multiple times while teaching to carry distracted students along
- ii. Legacy mode of learning architecture focuses only on academic result performance target which usually causes anxieties and pressure on part of tutors to finish architectural syllabus without minding if students are psychological ready or not to learn
- iii. Learning architecture is unproductive because of reliance on tradition teaching mode which doesn't give enough time for architectural students to ask questions or for tutor to determine students that are shying or confused from asking questions
- iv. It leads to low learning curve/outcome in modern architecture because traditional classroom fails to redefine its modern knowledge transfer technique
- v. Traditional mode of learning causes inequality in term of learning level among architecture students because of varying educational backgrounds and degrees of understanding
- vi. It produces incompetent/unskilful graduates of architecture because its mode of learning is centred on theoretical learning parts of architecture instead of supporting mode of learning that encourages critical thinking, innovation and creativity like gamified learning or blended learning mode
- vii. Traditional classroom mode of learning lacks quality lecturers/tutors that can impact sound practical oriented modern architectural knowledge on contemporary students that are already exposed to computer digital games, entertainment, sport betting and watching movies outside classroom context
- viii. Student to teacher ratio (50:1) in traditional architectural learning environment is not proportional enough to meet modern learning requirement for productive learning outcome

- ix. Insufficient funding of architectural classroom equipment and supplies is responsible for why traditional learning system remains ineffective mode of modern teaching and learning of result oriented architecture

1.3 Aim and Objectives of Study

Aim is to develop mobile based gamified learning application that will assist students of architecture to learn at their own paces using concept of gaming approach and to redefine learning by replacing current traditional learning system in use at ATILIM University architecture department to serve as academic model framework for other departments and institutions.

Objectives of this study are:

- i. To make architectural students learn in relaxed atmosphere since learner can retry learning multiple times after failing
- ii. To review current traditional learning system at ATILIM University to spot inadequacies required for future academic improvement
- iii. To offer architecture department of ATILIM University alternative way of achieving standard quality education in modern architecture
- iv. To introduce learning system that will integrate more fun into contemporary architecture classroom education and helps students that are exposed to gaming environment learn faster
- v. To encourage learning that allows higher concentration and interactive engagement among students of architecture
- vi. To permit architectural students to be in control and learn at paces that work best for them
- vii. To formulate modern teaching aids and model of transferring contemporary architectural knowledge to students via gaming technique unlike discrepancies created by traditional learning system via textbooks
- viii. To move architecture students closer to modern computing by boosting their architectural gaming skills in resolving problems
- ix. To make learning remains entertaining and visible via academic progress indicators

- x. To accommodate hybrid learning in content quality delivery through mixture of text, video, animation and audio as blended learning format
- xi. To help architectural students think outside the box to solve problem as against filling the box approach in traditional learning system

1.4 Significance of Study

If this gamified learning application development prototype for architecture students is granted permission, its distinct significance/impact in gamified learning can never be undervalued. After end of this project period, following significances are expected once gamified learning implementation approval is granted:

- i. It will surely replace and resolve existing problems that relate to conventional face-to-face learning system in use at ATILIM University for architecture students
- ii. It will contribute to improvement of students' motivation, concentration, engagement and others positive academic experiences among ATILIM University students learning architecture
- iii. It will help develop gamified learning application that has capability to match each architectural student's preference, characteristics and academic needs
- iv. It demonstrates capability to teach/learn complex and modern multi-disciplinary skills in entertaining, enticing and efficient way
- v. Proper gamification/game technology implementation will permit architectural students learning basic architecture to understand, retain and engage complex practices in fascinating manners

1.5 Scope of Study

This study implements functions that offer support to mobile based gamified learning environment where architecture students, lecturers and admin have separate login interfaces. Area of coverage includes these features:

- i. Individual login student has portal where gamified learning activities and other learning functions take place
- ii. It permits students to play their well known games while learning architecture
- iii. Tutor can upload learning resources while learners can keep learning from new resources

1.6 Deliverable

Implementation of mobile based gamified learning system to improve learning interest of architecture student is expected to be delivered to department of architecture, ATILIM University on behalf of architecture students as target client to serve as alternative solution that will improve learning outcome among students as against current conventional face-to-face learning that is not self-paced. If full gamified learning application is implemented; it will become future model upon which other institutions in Turkey will see as references to implement their own. For this mobile based gamified learning application to achieve academic objectives, detail documentations is required to offer information regarding application implementation, working-functionalities and design specifications. Manual documentation report that contains hardware-software-specifications, mobile “.apk” file, relevant databases and application flowchart will serve as deliverable content to ATILIM University after implementation to use as reference guideline during software installation and operation. More reasons why deliverable justifications are important are:

- i. New proposed gamified learning deliverable application is self-paced learning that is even cost-efficient when compared with traditional face-to-face classroom learning in use at ATILIM University
- ii. Expected deliverable gamified learning application is simple and interactive enough for architecture student to operate in order to improve his/her learning interest for purpose it was built
- iii. Security of gamified learning deliverable application will improve compare to conventional face-to-face learning system

1.7 Project-Plan and Methodology

As part of proposed project plan, mobile based gamified learning application is aim at improving learning interest of architecture student at ATILIM University and makes it easy for student to learn independently at their own paces. Proposed mobile based gamified learning application development is database driven which intends to follow client/server architecture pattern in design approach. New proposed gamified learning management system is mobile based android application for architecture students; it focuses on using Waterfall Model as major implementation methodology,

but will certainly blend prototyping models with it to achieve proposed mobile application for gamified learning that will meet pre-planned objectives for building alternative learning methodology to deliver top-notch quality education resource for architecture students of ATILIM University irrespective of statuses and physical conditions. Listed below represents gamified learning waterfall model procedures to follow in different phases as in figure 1.3 below:

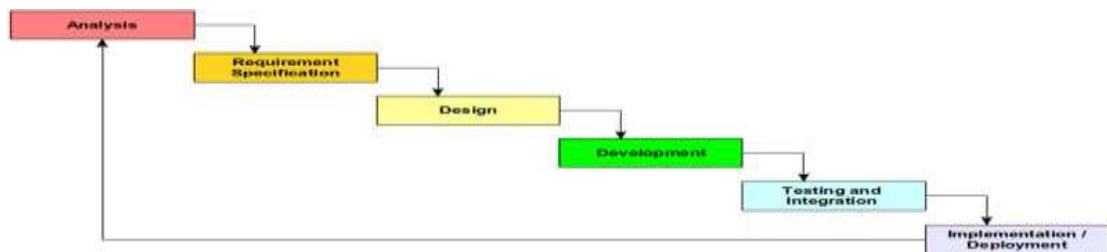


Figure 1.3: Gamified Learning Waterfall-Model Methodology in Project Planning

Methodology used is divided into many smaller units/modules for easy handling; each module/unit will be implemented with Java, Google SDK and Basic4Android to build frontend interface for gamified learning management application while PHP and MYSQL will help to build backend database interface for gamified learning where necessary. Some data collection techniques to gather data from different sources for development of gamified learning management are: Surfing-Web Method, Inspection Method and Interrogative Method.

As part of project challenges facing implementation of mobile based gamified learning system to improve learning interest of architecture student at ATILIM University, cost and timing remain part of implementation project challenges that needed to be overcome. Inadequate time allotted for development and supervision of this application remains another challenge that must be factored-in during project planning. Cost of gamified learning implementation is another vital issue of discussion during project planning especially if live-hosting on online cloud like Google Cloud, AWS or Microsoft Azure is desired because of varying high-cost of live-hosting. However, schedule timing for implementation of mobile based gamified learning has been drawn and adhered to in order meet project schedule for application implementation, software testing/evaluation, server-deployment and documentation writing:

1.7.1 Timetable

September/Oct	Submission of project proposal for supervisor approval and research commencement
Oct	Open proposal defence discussion with supervisor on given proposal
Oct Week2	Design of mobile gamified learning frontend interface and database environment installation
Oct Week 3 – Nov Week1	Completion of gamified learning frontend/backend
Nov Week 2 - Nov Week 3	Gamified learning application test-running of frontend
Nov Week 4	Gamified Learning Testing on Localhost Server Configuration for backend
Dec. Week 1	Discuss gamified learning project documentation/report with Supervisor
Dec. Week 2	Finalizing Gamified Learning Report and Commencement of Presentation Slide

1.7.2 Functionality

Project planning for mobile based gamified learning must permit application functionalities that are core to fundamental objectives of ATILIM University. Listed below are gamified learning functionalities expected in proposed system:

- i. Application will offer login account to students to serve as access control within the proposed application.
- ii. It will use points, progress bar and other feature as reward to boost student interest in gamified learning application.
- iii. Different popular games will be built due to familiarity to many students and adapt to learning content that will improve learning outcome.

1.8 People

Success of this application cannot be achieved without contributions in various capacities from people during application testing, interview, deployment, documentation, evaluation and packaging.

- i. Members of architecture staff of ATILIM University
- ii. Student members of architecture department of ATILIM University

iii. Online Research Community Members where some interrelated documents were sourced

iv. Programmer fellows who assisted in application evaluation and testing

Assistance from experienced programmers and fellow programmer friends helped to obtain timely assistance during gamified learning application testing, deployment, packaging and evaluation to support success achieved in this application implementation

1.9 Resources

To achieve outstanding implementation on proposed mobile based gamified learning system to improve learning interest of architecture student at ATILIM University, following hardware/software resources are needed to support flawless implementation:

- i. Functioning Window based with minimum 4G RAM and 40Gig hard disk Free-Space where emulator for mobile testing and development environment will get installed
- ii. Laragon/WampServer installation is required for local-hosting possibility except if client decides to host on live-server
- iii. Installation of Android Google-SDK is necessary for android mobile development
- iv. Computer needed for this task must run on windows XP operating system as minimum or higher version if available
- v. Android mobile phones are required to run implemented application
- vi. MYSQL/PHP is used for backend development of database design

1.10 Research Questions

- i. Can gamification help to determine improvement in learning outcome for architecture students?
- ii. Can there be any barrier as obstacle against adopting gamification for learning in architecture department?

1.11 Definitions of Terms

Automated: This is application of machine to run manual task.

Classroom: Is physical location where learning and teaching activity take place

Computer: This is electronic device used to carry out automated task through programming instruction

Data: This represents combination of words, Figs and values required for information processing

Gamification: is addition of game mechanic to other forms of activities outside gaming context

Gamified learning: is act of learning system that utilizes game based mechanics and elements to enhance academic learning in non-gaming context

Internet: It is worldwide link of networks that communicates together and remains accessible to public, private and individual user

Learning: is process of growth perceived due to changes in human disposition over certain period of time

Traditional classroom: is physical face-to-face building where learning and teaching take place

CHAPTER 2

LITERATURE REVIEW

2.1 Historical Background of Gamified Learning System

Concept of gamified learning began with Boy Scout popular recognition awards to achievers among them who worked harder to earn badges to boost their morals. In 1973, Game of Work was introduced by Charles Coonradt through art of writing to address flagging productivity challenges in US while that of sport and recreation related sales were improving in sales. Charles suggested introducing games-and-fun to improve productivity. MUD1 was later developed as first ever multi-user dungeon game by Richard Bartle and Roy Trubshaw with text-based user interface for online gaming. As computer user engagement was growing, different articles started showcasing capabilities of using computer games to improve productivity. MUDI developer was able to define types of gamer based on approach of people while playing game; this eventually became bedrock of gamification. In 1999, game mechanics began to become popular which was believed to increase workplace productivity. Bunchball was developed in 2005 to increase website engagement via addition of extra layer for game mechanics.

In 2009, foursquare app was introduced to help users discover and search new places as well as collect achievement or badges. In 2011, inaugural summit was held with about 400 attendees where release of Reality is Broken gamification came into existence before another workshop on “Gamification: Utilizing Game Design Element in Non-Gaming Context” was held in the same year. Gamification app concept later spread beyond exercise and language learning apps starting from 2018; it extended to areas like Job application, meditation, waste management, and to-do-list apps. Today, gamification concept has extended to other areas of life including architecture

2.2 Understanding Blended Learning Model for Gamification Management Scheme

Significance of blended learning model for gamification management scheme has now been unfolded after monitoring series of challenges students are facing before coming for lectures in face-to-face classroom, get relevant hard cover materials to boost their learning activities and get carried along by instructors. In blended learning environment, academic content is delivered by utilizing online learning and conventional learning system where students have little control over learning flexibility in term of pace and time of learning. Blended learning works well with gamification management by integrating game concepts like rules, points, levels and objectives into non-gamified context [5]. Gamification sets goal for students to work through while learning with great motivation via blended online or offline learning approach. Gamification makes it possible for students to learn in paces level by level before proceeding to another level. Students that struggle to catch-up or understand one level can slow down until he/she understands while learning in offline or online blended mode. Blended learning for gamification scheme enhances learning and teaching experiences due to boosted motivation of learners/tutors through gamified learning techniques; and also because of freedom of learning flexibility that offers them opportunities to express themselves anytime and get responded to with instant feedback. For blended learning in gamification management, information about gamified learners and tutors can be mined for further academic improvement purposes and other suitable sentimental analysis techniques [6]. School administrators can use extracted information to plan academic management or take certain decisions that will further lead to improvement of gamified learning and teaching

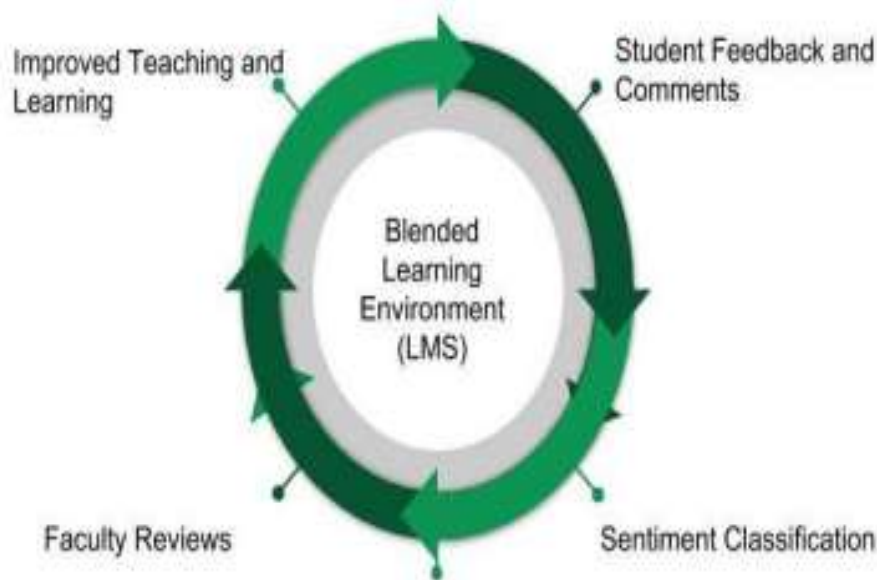


Figure. 2.1: Blended Learning Model for Gamification Management (Kavitha, 2019)

According to [7] submission, blended learning has lots of models that can benefit gamification as suggested by academic and educational research institute:

- i. **Face-to-face (F2F) model:** In blended learning model like this, teacher remains major focus in F2F-learning system that offers support to gamification schemes through provision of multiple digital learning tools that can motivate students to learn in any blended mode
- ii. **Rotational-model:** This kind of blended learning solution supports gamification scheme by giving chances to students to cycle from beginning to end scheduled F2F classroom learning through boosted motivation for online study-time
- iii. **Flex-model:** Model of this type permits gamified learning to get delivered at self-pace within blended learning environment via obtainable digital platform where tutors can also be available to offer extended learning support/consultation during F2F classroom learning
- iv. **Lab-model:** In this blended learning model, gamified learning is delivered to students via accessible digital platform within physical learning location. Learners can participate in conventional classes along with this type of gamified induced model mode

- v. **Self-blend model:** This blended learning model type permits learners to offer gamified learning support to traditional learning model with obtainable online course materials

In blended learning model for gamification management environment, many social components like Twitter, chat-room, blog, Facebook, Skype, email, YouTube, webinars, blogging, podcasting, web boards, e-learning and conference calls can be incorporated together for improved gamification system that has capability to motivate students to learn at their own paces

2.3 Types of Gamification in E-Learning Basic Architecture

There is no single technique adequate to gamify student learning program; individual student and learner's need must be put into consideration when developing gamified curriculum for architectural students or when gamifying academic training content as well as incentivize student performance. According to [8], there are two types of gamification that include:

- i. **Content Gamification:** This type of gamification learning works well with existing learning content by making it more engaging and interactive to enable students feel motivated to learn more. It is very easy to adapt if existing learning materials are gamified compliant; just with little adaptation, it can be made more engaging for learners. Gamification elements like simulation and storytelling can be added to existing learning content to keep students motivated in learning instead of starting off with learning without motivation. Even though it sounds as counterproductive, multiple assessments are better if included with gamified content to serve as obstacles that will create great motivation for learners to overcome before getting rewarded. It also helps learners to revisit failed attempts until they master learning content effectively

- ii. **Performance Gamification:** This kind of gamification is required in application that needs complete face-lift or application that is at stage of development by adding gamified elements like challenge and level modes to learning activities to boost motivations and learning outcomes. Performance gamification major purpose is to

direct students on their learning journey experience and motivate them to keep them engaged with learning. Motivational quotes or messages can also serve as encouragement words to boost student performances

2.4 Essential Elements of Gamification in Learning Architecture

Gamification learning in architecture is fast growing at high-speed; expectation is that it will grow higher because modern learning technique can no longer depend on brick-and-mortar architecture classroom when gamified learning offers motivation, flexibility and interest that are needed for students to enjoy motivated learning everywhere and anywhere they are located. Gamified learning leverages on blended learning approach to get boosted learning from any global location at real-time. In any digital learning environment, no particular application can perform every required learning/teaching function. Gamified learning can boost learning outcome among architecture students by removing every constraint to enhance learning features in architecture with zoom integration, Google Classroom and Google Drive [9]. Incorporating third-party features to gamified architecture learning can enrich academic complexity that may help students to achieve boosted learning experience. To implement gamified learning technology for architecture students, some learning functions are expected as motivation to boost student learning experience to achieve improved learning outcome. Listed features below are expected within gamified learning environment for architecture students [9]:

- i. **Peer-2-Peer Voice Chat:** Parts of gamification of learning is to integrate voice chat to give natural feeling and links gamified learning participants from architectural students together end-2-end at real-time. Audio in gamification learning is not really demanding like gamified video, but rather better than text learning only because students flow naturally with it than text-messaging even though it lacks visual sense

- ii. **Video Live-Streaming:** Videoconferencing has been in business environment for many years to enhance group collaboration and motivate members to responsibility. Today, students can appreciate video content if integrated in gamified learning; it has capability to motivate students when they are exposed to hands-in-practical do-it-yourself learning system. This mode of gamified learning can handle big-classes

through video conferencing learning to teach many gamified learners. In this mode of gamified learning, students feel motivated to learn because environment looks like being in conventional F-2-F type of classroom where individualized learning is carried out

iii. **File-Sharing:** Every network or virtual based learning system shares important files or academic materials together among student-to-student or teacher-to-student relationship. Gamified learning may also require end-2-end file-sharing features via direct peer-2-peer, cloud computing storage or third-party integration like One Drive/Google drive. This may motivate student to learn because assignments can be shared between teacher-to-student or student-to-student within gamified learning environment

iv. **Text-Messaging (SMS):** this element is not common with gamified learning but it can boost communication and interest to learn among students especially in group collaboration learning system

v. **White-boarding:** Gamification of learning can be more motivated if whiteboard is incorporated to mimic physical white-boarding in F-2-F classroom where annotating, writing and drawing experience is allowed in gamified learning system to boost interest of students to learn. It permits teacher and learner to import rich-multimedia video/audio content to replicate whiteboard experience that is usually witnessed with traditional F-2-F learning via big-touch monitor to boost real-life learning motivation

2.5 Challenges facing Mobile based Gamified Learning System

In recent Corona-virus global pandemic event, mobile based gamified learning system replaced conventional learning in many countries of the world due to diverse restrictions imposed on traditional learning including social distancing and reduction in numbers of students that must sit together inside conventional learning classroom to prevent spread of corona-virus. During this pandemic, lots of challenges that are facing traditional learning system, tutors, students, parents and university academic

management were exposed while modern digital solutions were introduced to resolve existing challenges. Some solutions were introduced by teachers to offer students opportunities to learn and overcome conventional learning challenges. If teachers are given right technological tools like mobile devices, internet and PDAs, it will help them engage their students efficiently in simple form. As gamified learning is utilized globally, it offers management tools, multi-OS support, multi-school management and parental control system. According to [10], challenges of gamified learning are:

- i. **Right Technology Investment:** Today many schools are under pressure to invest in academic technologies like mobile gamified learning tool to offer support to learning outcome. Right technology must be employed at the right time to obtain accurate and right result. Some schools fail to learn how to improve learning interest of their students because they use wrong technologies that do not add values to learning of their students. Mobile based gamified learning must be used for conventional physical classroom and distant learning students to improve their learning interests
- ii. **Teacher Feels Unsupported:** Some technologies may feel intimidating to teachers at times and render teachers ineffective. To overcome this, there is need for constant training and retraining of teachers on modern academic related technologies in order to gain confidence in teaching their students with latest technologies like mobile gamified learning to improve learning interest among students
- iii. **Parent Collaboration Involvement:** Parents must exercise their duties by contributing to education improvement of their children. Some schools setup virtual PTA for parents at night to help them collaborate with teachers to permit their children to learn using different available digital solution provided by school like mobile based gamified learning application to improve learning interest of their children especially in courses like architecture and engineering where practical is needed

- iv. **Gamified Learning Environment at Home:** Creating gamified learning environment at home may have great impact on learners. In many homes, environment is usually distractive; remote working parents and students require quiet places to support learning [10]. Teachers may recommend noise-cancelling headphone and Chrome-book to students to cope with noisy environment while learning through mobile based gamified application to improve learning outcome
- v. **Enhancing Internet Security for Student:** There is need to safeguard students while using gamified learning application via internet; internet must be restricted by administrator where necessary to avoid distraction or accessing prohibited contents for students [10]. Security application and appropriate firewall must be setup to prevent online threats
- vi. **Handling Distraction:** Keeping students focused and engaged in conventional learning classroom is challenging which is even worse within gamified learning environment because tutors can't see students if they engage with exact gamified learning materials or being distracted with other un-educative videos or online games [10]. Teachers must be equipped with software to monitor students' screen during learning in order to send warning/caution or remotely locked-off students being distracted during gamified learning lessons. Students' reviews or log may also be monitored during or after lessons

2.6 Review of Literatures on Gamified Learning Management for Architecture Students

This section shows some existing cited literatures that are interrelated to importance of gamification in learning system, some cited reviews are:

- i. According to [10], investigation was carried out on how games are used in building community and employed as communication tools. Different student-driven games were utilized depending on how those games could bring people together and create consciousness and motivation among those that play them. With this research, intention is to understand how games can stimulate intelligent motivated environments by finding out how digital games can boost individual and corporate

user experiences within urban based environment via gaming components like story-telling, visualization and spatial-geography

- ii. [11]; defined gamification as inclusion of game-like elements in conventional non-gaming environments in order to achieve particular goal through motivation experience of user or modelling behaviour. One essential methodology in educational gamification focuses on design of modern educational activity that is tailored around individual behaviour and preference as obtainable in commercial games where game elements are embedded in educational curriculum to boost children's cognitive thinking, learning and further engagement in life
- iii. [12], examined effect of gamification on motivation and engagement on models of instructional design in gamification that allows implementation of experiences that simulates design of (video) games, giving individual opportunity to draw cards, gamble, trade, attack, compete, cooperate, and more
- iv. In [13] submission, she pointed out as game designer and director of Institute of Play that focused on learning and non-profit game design promoter. She later introduced "Quest to Learn" into public middle-school in order to utilize gamification technique to change/transform traditional classroom learning environment via curriculum redesign to teach conventional learning material as gamified modules. Quest to Learn initiative was based on design principle that permitted playing with students as teachers acted role of designers in gamified learning approach. This initiative was able to expose students to more complex problem solving challenges while engaging in traditional classroom learning as enhanced gamified methodology. It was also found out that this approach helped to develop spatial reasoning, value judgment and critical thinking of target students. Enhanced curriculum in gamified format made learning content became fluid and easily customized/adaptable to each student needs
- v. According to [14], gamification has been explored in the context of introductory architectural education by examining its efficacy, impact on motivation and engagement on instructional design models to provide valuable insights into

potential of gamification which enhances learning outcomes in architecture education

- vi. [15], explored implementation of social networking and open-form based teaching in gamified learning by using concept of blended learning and gamification elements. Researcher designed business game where participants were divided into different interdisciplinary teams that are responsible for management of 3D-visualization task. These teams were trained on concept, implementation and development stages regarding project tasks before being evaluated and rewarded with play-tokens for game benefits that are usable in future visualization task. Game's social elements showed importance of gamification in networking component to improve collaboration within environments where game players or learners were unable to work together. However, its social dynamics were able to improve teamwork, social skill and boost collaboration among many student groups especially when gamified elements like play-tokens were involved to boost interest, motivation and enjoyment
- vii. According to [16], emphasized on exploitation of gamification, game design and VR/AR technology in future architecture training through EDUGAME4CITY initiative financed project. It included multi-step viability that is applicable to urban-design project for architecture students. Urban intervention project was accomplished by students that employed gamified learning elements, VR-modelling and component. This project revealed many gamified elements of gamification in architectural learning education by providing evaluation for the design before commencement of construction Gamified approach made it possible to through game simulation reviewed from different point of views, skill retention and positive engagement among students

CHAPTER 3

SYSTEM ANALYSIS AND DESIGN

3.1 Introduction

Gamified learning design and its analysis remain main focus of this chapter where techniques and tools employed in research of mobile based gamified learning system to improve learning interest of architecture student is discussed to include study areas like design consideration/architecture, system coding approach and existing analysis review.

3.2 Analysis of the Existing System

Existing system is traditional face-2-face learning system which is non-gamified in nature. Careful analysis of existing physical traditional learning environment for architectural students at ATILIM University architecture department reveals that certain face-to-face activities occur which include:

- i. Listening to class lectures
- ii. Regular attendance of classes
- iii. Note jotting and writing
- iv. Answering posed questions
- v. Listening to other students within the class

In existing conventional learning environment, it is difficult for students to get motivated while learning due to dull teaching moment from tutors during class meetings. In non-gamified learning environment, before access can be granted to attend physical classroom; lots of physical clearances and registrations may be required during admission processes by filling and signing different forms from one office to another before one can settle down to learn. In some schools like ATILIM University, fulfilling certain financial responsibilities remain criteria that must be fulfilled before granting access to attend lecture classes to learn architecture which increases pressure on students before they settle down for unmotivated learning. In many occasions at diverse traditional classroom learning environments, latest and

resourceful architectural learning materials are usually scarce; and where students are forced to pay for classroom architectural learning materials; they are not always delivered on time. Rigidity, structure and uniformity of conventional learning can become academically counterproductive for learners especially as many students that are not psychologically ready for architectural learning are forced to attend classroom lectures with their peers on effortless unproductive learning mission

3.3 Problems of Existing System

Non-gamified learning system is confronted with certain setbacks and limitations which hinders exactness and effectiveness of existing system. Some problems spotted in the course of data collection via hosted survey form and data processing reveal that in existing non-gamified learning system, following problems exist [15]:

- i. **Schedule stiffness:** It is difficult to combine study and personal or work life due to schedule stiffness. You have less control over when and where classes are held, which can make studying a challenge.
- ii. **Traditional education offers limited educational materials:** Videos, forums, pictures and educational materials are not always available. Study plans could be hampered by this feature and learning might be limited.
- iii. **Students who are introverted will not benefit from them:** When students who are introvert have to answer specific questions or infer conclusions orally in the existing system, they feel more pressure.
- iv. **Loss of Document:** Vital architectural documents containing students' learning records can be misplaced due to manual storage technique in use which can instigate problem for management and learning materials are not usually secure; books can be stolen or tore from the school library.

3.4 Analysis of Proposed/New System

New system is setup to eradicate or minimize ambiguities facing existing non-gamified system to deliver effective mobile based gamified learning system to improve learning interest of architecture student at ATILIM University and facilitates learning interaction between teachers and students irrespective of their locations worldwide via integration of telecommunication, game concept and modern web/mobile technologies. This new system is known as mobile based gamified

learning which is expected to resolve many associated non-gamified existing problems like transportation cost, long-time classroom sitting; lecturing style and lecture time restriction. Mobile based gamified learning system is not expensive but flexible because it extends motivated education to people with disabilities, difficult terrains, financial difficulties and people that blend working with schooling. It permits institutions of learning to offer opportunity for lecturers to connect with students to learn, upload assignment, upload course materials and carry out assessment for motivated students

3.5 Justification of New System

There are multiple reasons and justifications why proposed gamified learning system must be adopted for architecture department in ATILIM University. Gamification of learning solves many academic challenges that existing legacy education system finds trivial to address since many years ago. Although, face-to-face physical learning technologies and computerized applications have improved in recent years; but there is still lots of reasons to create more learning channels for architecture students as society is witnessing high increase in entertainment, computer games and sport betting which seem to influence students in classrooms as many of them play computer games secretly while teaching is going on, some get themselves equipped with computer game pads from their homes to play games at any available opportunity in school. Some other students also engross themselves in entertainment related activities like playing music or watching movies. To these sets of students especially those that are addicted to entertainment, game playing and sport betting, learning through traditional system is boring to them and no longer effective to make them learn tedious course like architecture in contemporary digital environment.

However, to inculcate skills and improve motivation to learn contemporary architecture practice, it is better to explore gamified learning approach to deliver quality architecture education to ATILIM University students in entertaining manners that will lead to improved academic productivity and self-reliance. Some major justifications why gamification of learning must be allowed and developed as modern learning technique are:

- i. Academic stake holders can join this learning technique to existing face-to-face learning at ATILIM University to serve as improved blended learning for architecture students
- ii. Gamified learning promotes inclusiveness by allowing disabled and able-architecture students to learn and get motivated together without discrimination in learning system
- iii. It offers extension to existing learning methodologies by ensuring quality education is shared and distributed without border or compromise
- iv. In time of academic disruption or global closure like pandemic Covid-period, gamified learning can offer academic continuity

As gamified learning gets accepted, many more positive occurrences will emerge which will tend towards moving quality education to greater height as students are motivated to climax to learn better with result oriented academic outputs to show for it in term of competence, employability, skilfulness and productivity in modern architecture practice

3.6 System Software Design

System design for mobile based gamified learning system to improve learning interest of architecture student at ATILIM University follows necessary procedures to design core application elements like software module, component and interface designs in order to make requirement provisions for software/hardware components. Each software module is built with Java, libGDX, B4A, XUI2D and Google-SDK. Database part of software design employs MYSQL and SQLITE database language to implement software backend. System design for mobile based gamified learning system to improve learning interest of architecture student at ATILIM University is classified into four modules:

- i. Output software design system
- ii. Input software design system
- iii. Process software design system
- iv. Database software design system

3.6.1 Output Software Design System

At this phase of system design, output system design displays how final results will be displayed after real-life implementation is modelled in line with GUI interface. It is foremost design phase that one must go through because output determines what input may look like while processing-input determines what output may look like. System design offers diverse options and design techniques to use for mobile based gamified learning application to improve learning interest of architecture student at ATILIM University. Tables below illustrate design expectation from output data when it is implemented:

REPORT SAMPLE FORMAT:

- 1. MOBILE GAMIFIED LEARNING SYSTEM**
ATILIM UNIVERSITY, ARCHITECTURE DEPARTMENT
SNOOKER GAMIFIED LEARNING
LIST OF SNOOKER LEARNING ENGAGEMENT
DATE.....

Table 3.1: List of Snooker Gamified Learning Engagement

S/N	No of Ball	Ball Object	Ball Mass	Ball Radius	Ball Diameter	Friction
1	8	pottable balls	60.0	90	180	0.981
2	16	pottable balls	30.0	45	90	0.896
3	32	pottable balls	15.0	22.5	45	0.796
4	64	pottable balls	7.5	11.3	22.5	0.696

- 2. MOBILE GAMIFIED LEARNING SYSTEM**
ATILIM UNIVERSITY, ARCHITECTURE DEPARTMENT
INVADER GAMIFIED LEARNING
LIST OF INVADER LEARNING ENGAGEMENT
DATE.....

Table 3.2: List of Invader Gamified Learning Engagement

S/N	No of Invaders	Available Bullet	Shooter Speed	No of shoot-down	Invader Speed
1	15	2000	0.5% x	8	0.6% x
2	30	3000	0.5% x	4	0.6% x

3	45	4000	0.5% x	15	0.6% x
4	60	5000	0.5% x	10	0.6% x

3. MOBILE GAMIFIED LEARNING SYSTEM
ATILIM UNIVERSITY, ARCHITECTURE DEPARTMENT
DICE GAMIFIED LEARNING
LIST OF DICE LEARNING ENGAGEMENT
DATE.....

Table 3.3: List of Dice Gamified Learning Engagement

S/N	Dice 1	Dice 2	Timer 1	Timer 2	Point
1	2 faces	1 face	10secs	10secs	30
2	3 faces	5 faces	12secs	12secs	80
3	6 faces	6 faces	10secs	10secs	120
4	4 faces	5 faces	9secs	9secs	90

4. MOBILE GAMIFIED LEARNING SYSTEM
ATILIM UNIVERSITY, ARCHITECTURE DEPARTMENT
USER LOGIN
LIST OF USER-LOGIN TO GAMIFIED LEARNIG APPLICATION
DATE.....

Table 3.4: List of User-Login to Gamified Learning Application

S/N	User-Name	Password	Level	First-Name	Last-Name	Department
1	Alex	alex22	200 level	Alex	Martin	Architecture
2	Yagmur	Aslan	400 level	Yagmur	Aslan	Architecture
3	Ilesanmi22	Dolapo22	300 level	Ilesanmi	Dolapo	Architecture
4	Alper	Adil	100 level	Alper	Adil	Architecture

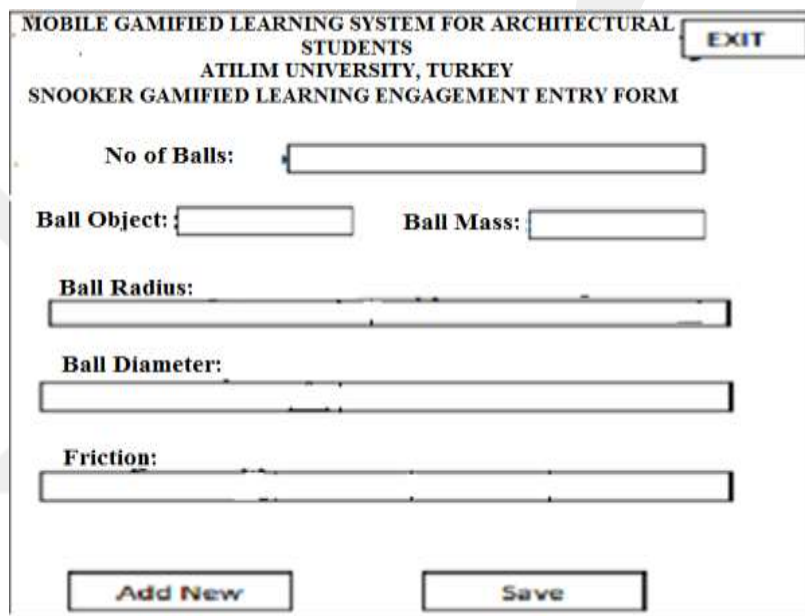
3.6.2 Input Software Design System

Mobile based gamified learning system requires user's keyboard inputs which gets converted to computer acceptable format; it is very important portion of program flow because wrong input can cause inaccurate data entry which may lead to errors in data processing. Three out of many sample forms utilized for data input requires

for mobile based gamified learning application to improve learning interest of architecture student at ATILIM University are revealed below:

- i. Snooker Gamified Input Form
- ii. Invader Gamified Entry Form
- iii. Dice Gamified Entry Form
- iv. User Login Form

Snooker Gamified Input Form: This input-form helps to collect different inputs and parameters from application and learner to run snooker gamified application



MOBILE GAMIFIED LEARNING SYSTEM FOR ARCHITECTURAL STUDENTS
ATILIM UNIVERSITY, TURKEY
SNOOKER GAMIFIED LEARNING ENGAGEMENT ENTRY FORM

EXIT

No of Balls:

Ball Object: Ball Mass:

Ball Radius:

Ball Diameter:

Friction:

Add New Save

Figure 3.1: Snooker Gamified Entry Form

Invader Gamified Input Form: This entry form helps to collect different inputs and parameters from application and learner to run invader gamified application

Figure 3.2: Invader Gamified Entry Form

User Login Form: This form helps application user to enter password and username before granting permission to engage with mobile gamified learning application

Figure 3.3: User Gamified Login Entry Form

3.6.3 Process Software Aanalysis

Application development for gamified learning processes information collected from users once captured login entries are successful into mobile based gamified learning application to improve learning interest of architecture student, login details are automatically created. Learners can improve their learning and cognitive capabilities by learning as they interact with gamified learning games on architecture

3.6.4 Database Software Design System

Data for mobile based gamified learning application to improve learning interest of architecture student is saved and directly retrieved from gamified database when necessary. Designing database can never be ignored for mobile based gamified learning application. Data elements required for gamified application are collected during preliminary stage of development. Database contains group of record stored with minimal redundancy to serve many application users. Major focus of database objective is to maintain access to database and improve its security against data breaches/thefts. MYSQL database is the choice of this researcher to implement mobile based gamified learning application to improve learning interest of architecture student for ATILIM University. At design development stage, following tables are involved in gamified application development:

1. Table Name: snooker.sql.

Purpose: For keeping inputs and parameters for snooker gamified learning

Key-Field: No_of_ball

Table 3.5: Snooker Gamified Learning Database

FIELD-NAME	DATA-TYPE	FIELD-LENGTH	DESCRIPTION
No of Ball	Numeric	10	Number of snooker ball to play
Ball Object	Alphabetic	32	Snooker ball id
Ball Mass	Numeric	10	Snooker ball mass
Ball Radius	Numeric	10	Snooker ball radius
Ball Diameter	Numeric	10	Snooker ball diameter
Friction	Numeric	10	Used to calculate force applied
Learning Content	Blob	5000	Architectural learning resource in text, audio, video and animation

2 Table Name: invader.sql

Purpose: For keeping inputs and parameters for invader gamified learning

Key-Field: available_bullet

Table 3.6: Invader Gamified Learning Database

FIELD-NAME	DATA-TYPE	FIELD-LENGTH	DESCRIPTION
No of invader	Numeric	10	Total number of invaders
Available Bullet	Numeric	500	Quantity of ammunition
Shooter Speed	Numeric	10	Speed of shooter to hit at target
No of Shutdown	Numeric	10	Numbers of alien invaders shut down
Invader Speed	Numeric	10	Invader speed to take over earth
Learning Content	Blob	5000	Architectural learning resource in text, audio, video and animation

Table Name: dice.sql

Purpose: For keeping inputs and parameters for dice gamified learning

Key-Field: points

Table 3.7: Dice Gamified Learning Database

FIELD-NAME	DATA-TYPE	FIELD-LENGTH	DESCRIPTION
Dice 1	Alphabetic	15	Identification of dice 1
Dice 2	Alphabetic	15	Identification of dice 1
Timer 1	Numeric	10	Timing for dice 1
Timer 2	Numeric	10	Timing for dice 2
Points	Numeric	10	Gamified learning reward
Learning Content	Blob	5000	Architectural learning resource in text, audio, video and animation

Table Name: login2k.sql

Purpose: To keep gamified user engagement details before granting permission to engage with mobile gamified learning application

Key-Field: department

Table 3.8: Sign-up Gamified Learning Database

FIELD-NAME	DATA-TYPE	FIELD-LENGTH	DESCRIPTION
Username	Alphanumeric	18	Gamified learning username
Password	Alphanumeric	18	Gamified learning password
Level	Alphabetic	18	Gamified learning level
FirstName	Alphabetic	43	Gamified learning firstname
LastName	Alphabetic	43	Gamified learning lastname
Department	Alphabetic	25	School dept user belongs

3.6.5 Functional Requirement for Mobile based Gamified Learning System

Functional requirement on gamified learning is concerned about purposeful relationship that is based on how academic application functionalities are built for architecture students to improve learning interest of student at ATILIM University. Functional requirement is crucial to realization of expectation on mobile based gamified learning application to improve learning interest of architecture students. Functional requirements in system software design involve dividing gamified learning complex functionality into simpler module units through functional decomposition tactic. In proposed gamified learning application operation, functional requirement highlighted some system behaviours that are needed in mobile based gamified learning application to improve learning interest of architecture student at ATILIM University:

- i. User of proposed gamified learning application can setup new student account for mobile based gamified learning system
- ii. School admin can handle gamified learning application backend maintenance and users

3.6.6 Non-functional Requirements for Mobile based Gamified Learning System

Non-functional requirements are types of gamified learning requirements that have no effect on running of proposed application, but it can only get affected sometimes in terms of program maintainability, application-extensibility and application-

documentation. Non-functional requirement for gamified learning is indirectly connected with program usability as shown in mobile based gamified learning application to improve learning interest of architecture students at ATILIM University. Listed below are parts of non-functional gamified learning requirements:

- i. Gamified learning application will be accessible to students and tutors from any remote location without having down-time experience
- ii. Gamified learning application is thoughtfully documented for whoever wishes to run this learning application in nearest future
- iii. Gamified learning application is implemented to improve learning outcome of architecture students at ATILIM University and makes modification becomes easy to achieve for better performance
- iv. Gamified learning application is resourceful, reliable and tested to meet academic application set objectives

3.6.7 Mobile based Gamified Learning Information Flow Process

Gamified learning information flow process shows approach to learning that uses game elements like points, competition and rewards to increase engagement and motivation by involving continuous cycle of learning, assessment, feedback and improvement. Learners will receive feedback from game that can be used to adjust their approaches and strategies. This feedback loop helps learner to understand successes and failures before making necessary changes for improvement. It is an effective way to learn, as it allows learners to recognize patterns and take action to improve their skills and knowledge. In fig. 3.4 below shows diagram for gamified information flow diagram

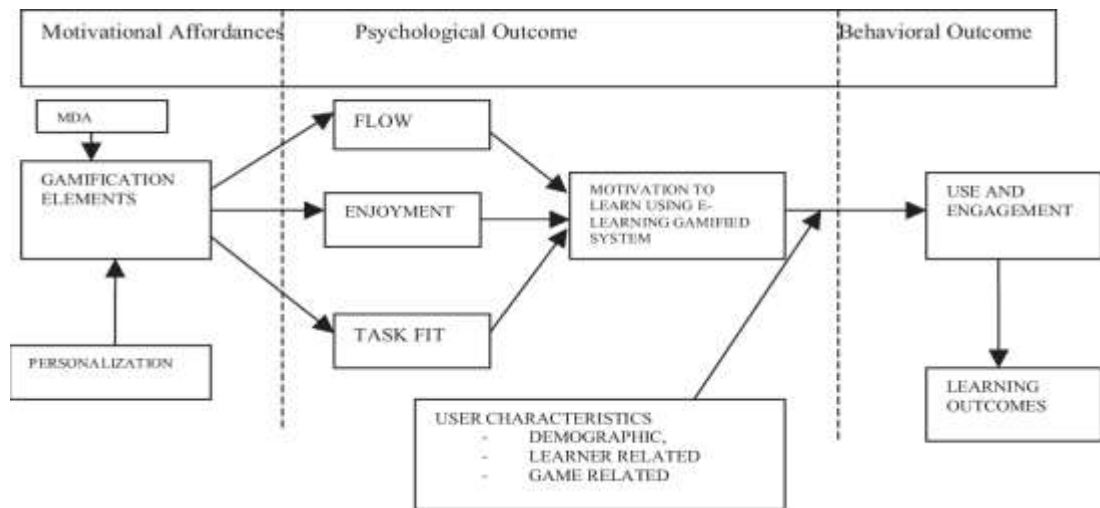


Figure 3.4: Gamified based Learning Information Flow Model (Kamunya et al, 2019)

Gamified based learning information flow model remains theoretical framework requires to understand game dynamics and learning to boost academic interest. It explains how student interacts with games through gamification elements, feedback and decision making which help to increase motivational level of learners by boosting knowledge retention and engagement via awarding of points, badges and leader-board components for academic improvement purpose.

In this research, data collection tools utilized for success of this research are:

- i. **Quizzes and Surveys:** these data collection tools were used to gain insights into user behaviour in order to provide valuable feedback on user engagement and preferences with gamified learning system. It helps to gather detail information about individual student's experience, motivation and changes in attitude towards gamification learning system
- ii. **Observation:** This data collection tool was used to observe players' behaviours and interaction with gamification elements as they play mobile based gamified leaning games on their phones which is carefully observed by researcher for better understanding of player engagement with the learning game
- iii. **Focus Group:** this data collection tool was used to help researcher engages in a discussion with group of players to discuss their experiences and opinions about gamified mobile learning system verbally and via post-survey form given to them

- iv. **Point-based System:** is another data collection tool used to collect points for completing certain gamified tasks or activities in order to provide users with recognition and encouragement needed to continue engaging with the learning game to unlock rewards or gain access to special application features

In terms of validity, data collected for this research remains accurate reflection of real-world events and interactions with architecture students through feedback received about gamified learning application for academic improvement purposes. However, in term of reliability, data collected for this research remains consistent and free from bias or systematic errors. In order to ensure further reliability of data collection tools used for gamification learning systems, data was collected from multiple sources to prevent bias and errors in order to ensure data is accurate and up-to-date

3.7 System Gamified Learning Testing Tools and Techniques

System testing-tool utilizes environment and code to design/implement mobile based gamified learning application to improve learning interest of architecture students at ATILIM University. For this gamified learning application to get wholly implemented, diverse gamified learning tools are employed for testing/evaluation purposes to spot if program meet up with target gamify learning specifications in conformity with objectives and aim set at commencement of this research. Listed below are few of testing-tools employed towards implementation of mobile based gamified learning application to improve learning interest of architecture students at ATILIM University:

3.7.1 Basic4Android Language

This is popularly refered to B4A; it is programming language that is used for android mobile application development. It entails designer environment interface to build mobile application for android smart phone and tablets with different screen sizes. Compiled gamified learning application can be tested and debugged with AVD-emulator or from real device. This B4A language looks like blended Visual Basic and Java but adapted to android native environment to build signed android mobile applications that are can be uploaded to Google Play, Samsung App store and

Amazon App store. Listed below are some vital features that make it choice language:

- i. It is easy and powerful RAD-tool for implementing native applications
- ii. It has design interface that centres on android mobile development
- iii. It compiles application to native byte-code without worrying about runtime dependencies before creating APK file
- iv. It has performance that is similar to Java based applications
- v. It is object based mobile programming language
- vi. It has powerful mobile designer script feature that is simple to create complicated layout

3.7.2 Android Google SDK

This Google tool is used beside B4A for mobile android application design; SDK is acronym of Software Development Kit which has components like sample code, libraries, QEMU emulator, debugger, documentation and tutorials. Developers can use text-editor like notepad or notepad ++ to edit XML and Java files via command-line tools. SDK offers support to older Android mobile version platform if program developer wishes to build with legacy devices

3.7.3 Use-Case Diagram

Use-case diagram demonstrates how users transmit feedback within gamified e-learning environment. It illustrates how diverse actors in the system can communicate together between GUI interface and database where vital information can get retrieved or inserted. Diagram below designates how users can get feedback responses from the system. Key entities in use case diagram for mobile based gamified learning application to improve learning interest of architecture students at ATILIM University:

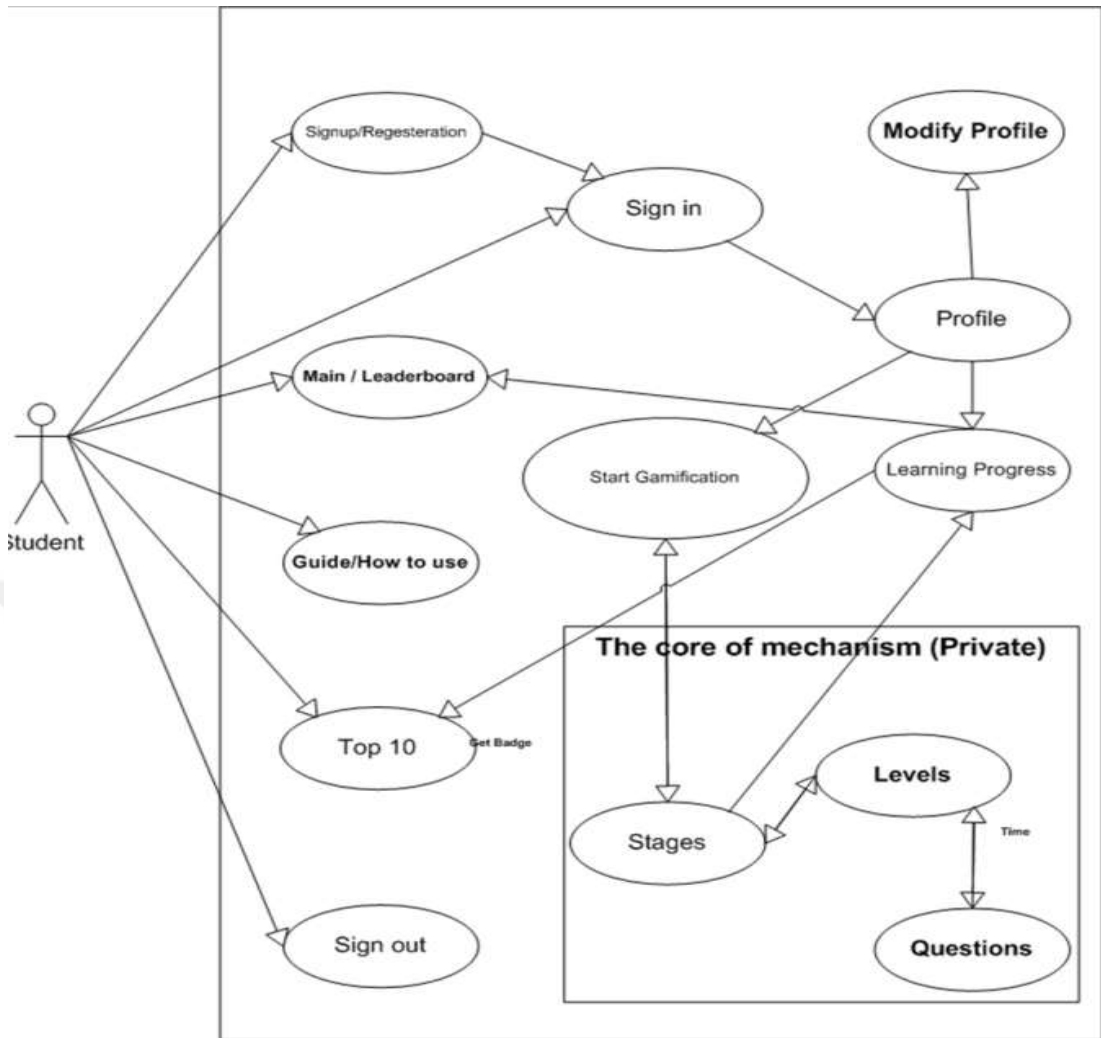


Figure 3.5: Use Case Diagram for Gamified Learning (Firas et al, 2020)

3.7.4 Static Class Diagram

Diagram of this kind is employed in field of software engineering to showcase detail of gamified learning static-structures through object relationship, attribute operation-warning and system classes. Fig. 3.7; indicates class-diagram for mobile based gamified learning application to improve learning interest of architecture students.

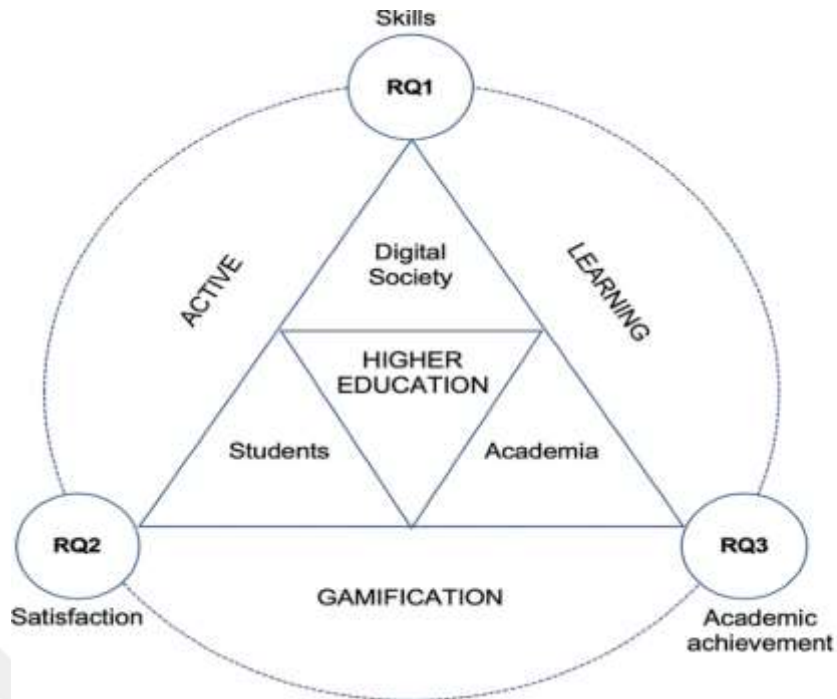


Figure 3.6: Gamified Learning Class Diagram

3.7.5 Entity Relational Diagram (ERP-Backend)

ER is widely called Entity-relationship diagram which forms part of charts used in developing flow cycle for proposed mobile based gamified learning management application that can come together as one entity. ER reveals how entities like people, concept and object harmonize together to realize proposed mobile based gamified learning application to improve learning interest of architecture students. It is sometimes called ERD or ER-Model; which constitutes symbols, entities and other connecting-lines to join different attributes together

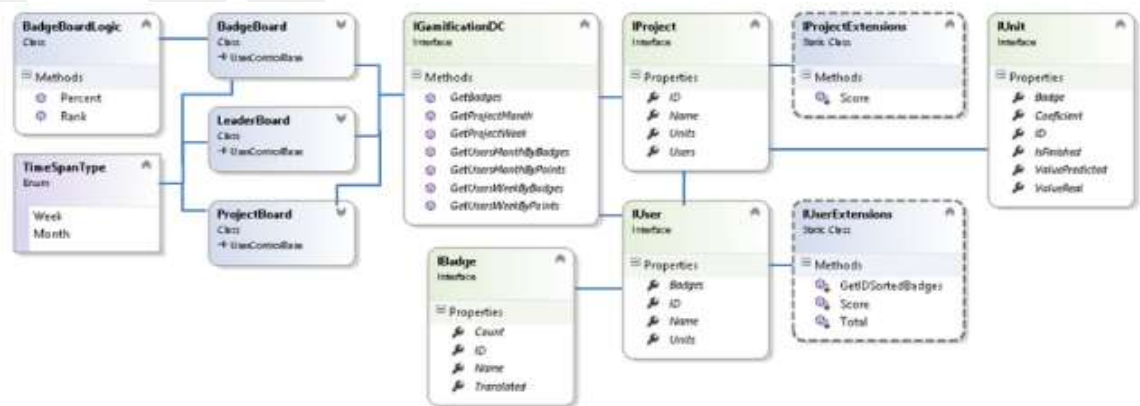


Figure 3.7: ER-Architecture Diagram for Gamified Learning

3.7.6 Mobile Gamified Learning Frontend Design Interface

Application interface of mobile based gamified learning application to improve learning interest of architecture student design helps ATILIM University to capture necessary data into gamified application. In proposed gamified learning application model, three interfaces including procedural interface, GUI-interface and data exchange are applicable. Frontend interface on mobile based gamified learning application to improve learning interest of architecture students started from manual sketch on paper; and after sometimes, it was translated to build application prototype interface before concluding implementation phase was done:



Figure 3.8: Front/Login Interface



Figure 3.9: Menu/Dashboard Interface Form

CHAPTER 4

SYSTEM IMPLEMENTATION AND DOCUMENTATIONS

4.1 Introduction

Central focus of this chapter is on project implementation and program documentation based on available information from chapter-three. It informs application users on many necessary hardware/software requirements that are needed to run mobile based gamified learning application to improve learning interest of architecture students at ATILIM University

4.2 System Implementation

Implementation of mobile based gamified learning application has been built; major concern now is on how to switch from legacy system to proposed new mobile based gamified learning application in order for ATILIM University students in architecture to continue using this new system. After successful development of this gamified learning application for ATILIM University; gradual replacement of traditional learning system must commence depending on opinion of school stakeholders on whether to continue or not with existing system. School stakeholders may also decide to use both systems at the same time until students and staffs get familiar with new mobile based gamified learning to improve learning interest of architecture students at ATILIM University. There are many choices on changeover methodologies that are available for selection without interfering with present working environment

4.2.1 Changeover Method

Summarized below are some application change-over techniques that gamified learning users can select from when changing from legacy to new mobile based gamified learning system like:

- i. Parallel-changeover scheme
- ii. Pilot-changeover scheme
- iii. Direct-changeover scheme

- i. **Direct-Changeover Scheme:** this kind of changeover permits gamified learning application users to instantaneously replace conventional system with new proposed mobile based gamified learning application. This changeover scheme is risky, but fast enough because minimal workload is required. Cost of setting-up this changeover scheme is inexpensive and doesn't waste time to implement. One intricacy with this changeover scheme is that during operation, application correction on proposed gamified learning is cumbersome to achieve
- ii. **Parallel-Changeover Scheme:** This remains safest changeover scheme to verify effect of new mobile based gamified learning application when runs it side-by-side in parallel with existing system for predefined durations in-line with standard comparison metrics. Using this changeover scheme can help reveal vulnerabilities of new mobile based gamified learning application before changeover takes place
- iii. **Pilot-Changeover Scheme:** this scheme allows management to select some architectural students within architectural department of ATILIM University to run new mobile based gamified learning application along with existing system. If proposed mobile based gamified learning does better, it will get approval of school management for continuous student usage in as legacy-scheme gets discontinued

4.2.2 Changeover Recommendation

Parallel-changeover scheme is recommended to architectural student of ATILIM University to improve learning outcome and facilitate integration of mobile based gamified learning application in school to replace classical learning system in use. This changeover decision is made due to careful study of different local/international academic application developers that have contributed before to school development by examining changeover-type adopted with reason. Choosing parallel-changeover scheme will permit ATILIM University management to learn further about proposed mobile based gamified learning application to improve learning interest of architecture students before making final decision on replacing existing system with new mobile based gamified learning system

4.3 System Installation & System Run

System installation is necessary for proposed mobile based gamified learning application. After implementation of mobile based gamified learning system to improve learning interest of architecture students at ATILIM University, proper application installation/configuration and running of this proposed gamified application requires clarification for adequate familiarity to deployment storage environment where mobile based gamified learning application for architecture students is expected to run without downtime to achieve predefined set objectives to improve learning interest of architecture students at ATILIM University

4.3.1 Hardware Specification

To attain successful installation/deployment in proposed mobile based gamified learning system to improve learning interest of architecture students at ATILIM University, following recommended listed specifications are necessary to meet minimum hardware requirements needed to run this mobile based gamified learning application; however, it is always preferable to aim at higher hardware specifications:

- i. Pent-iv (Pentium-4) at 2.40GHz processor speed
- ii. RAM of 64MB minimum
- iii. Hard-disk of about 20GB storage space
- iv. Working/functioning CD/DVD-ROM drive
- v. Working/functioning Mouse/keyboard
- vi. External-Speaker/Sound-card in good condition
- vii. Mobile digital phones/laptop in various screen-sizes
- viii. Uninterrupted Power Supply (UPS)

4.3.2 Software Specification

New system is mobile based gamified learning system to improve learning interest of architecture students at ATILIM University which targets mobile phones of different screen-sizes. This mobile based gamified learning application will work on any Android operating systems. Minimum entry of software requirements needed for mobile based gamified learning system application:

- i. This proposed mobile based gamified learning application runs on android operating system 4 or higher while windows-XP minimum operating system or higher will work for application development purpose
- ii. MYSQL/SQLITE database was used for backend design
- iii. Java, Google Android-SDK and Basic4Android were used for mobile gamified frontend design
- iv. Nox player was used as emulator environment

4.4 Choices of Programming Languages

Programming languages selected for mobile based gamified learning application implementation are: Java, Google Android-SDK, B4A languages and MYSQL/SQLITE which supports SQL query package; it can also eliminate application inconsistency, database redundancy and record duplication. It offers improved learning environment to architecture students of ATILIM University and makes provision for alternative data backup

4.5 System Documentations

Documentations help application developer to keep adequate information about proposed mobile based gamified learning application implementation, how it works, its functionalities, maintenance tips and operation requirements. Manual documentations of this proposed gamified learning system includes flowchart/algorithm for step-by-step software development and application operation approach. It makes novices to have proper understanding about general application setup for mobile based gamified learning due to detail documentation guidelines availability

4.5.1 Installation Process

Having developed mobile based gamified learning application to improve learning interest of architecture students at ATILIM University; application users should be guided on installation of gamified learning software via these procedures:

- i. Laragon/WampServer should first get installed
- ii. Now that Wamp installation is done, run WampServer/Laragon Server
- iii. Move to localhost “C:\wamp\www” in directory folder

- iv. Create folder named “gamified-learning” or use other easy to remember name for domain creation
- v. Open <http://localhost/phpmyadmin> via web-browser on address bar
- vi. From CREATE_DATABASE textbox, type: “gamified-learning-db”; and click on phpMyadmin CREATE button
- vii. After new database creation is done, click on IMPORT_Tab link or move to select “gamified-learning-db.sql” file from database deployment CD
- viii. Proceed by clicking on GO button to import, then populate with database records
- ix. Open database deployment-CD to copy appropriate contents to “c:\wamp\www\gamified-learning” folder
- x. Gamified learning database has just been setup for proposed gamified mobile application
- xi. Default school administrator login are
Username: gamifiedlearning
Password: gamifiedlearning
- xii. That’s it!

4.5.2 User Guide

New/Proposed mobile based gamified learning application built to improve learning interest of architecture students at ATILIM University is capable of running on different android operating system irrespective of mobile screen-size variations. Mobile emulators on computers and mobile android devices that have successfully worked with mobile gamified learning application are: Nox Player emulator, You-Wave emulator and different OS-versions of real-android mobile devices. To run mobile based gamified learning program:

- i. Copy mobile “.apk” file produced into mobile android device
- ii. Permit necessary settings to allow unknown signed-app to run on android device
- iii. Click on the “.apk” file on your android device to run it
- iv. Follow on-screen messages until installation finishes and run the app

4.5.3 System Software Maintenance

System software maintenance showcases different techniques available for maintenance of proposed mobile based gamified learning application to

run appropriately with improved performance that is error-free and consistent with application update to keep it running smoothly without experiencing downtime. System software maintenance techniques that can be applied to mobile based gamified learning application to improve learning interest of architecture students at ATILIM University are:

- i. Corrective-software-maintenance
- ii. Perfective-software-maintenance
- iii. Adaptive-software-maintenance

Perfective-software-maintenance is recommended for mobile based gamified learning application to improve learning interest of architecture students at ATILIM University. Out of plenty techniques meant to carry out effective application maintenance. Perfective-software-maintenance adds new favourable features to existing gamified program to boost software performance. For consistency in gamified learning application performance improvement, school management at ATILIM University must rely on using perfective-software-maintenance approach on new mobile based gamified learning application to improve learning interest of architecture students and to always deliver top-notch service

CHAPTER 5

RESEARCH METHODOLOGY

5.1 Introduction

This research part offers brief but comprehensive description of procedures involved in gamification research. It concerns research design methodology technique employs in solving research gamification questions, statement of hypotheses and required sample-size. It also indicates characteristic of population in terms of educational background, age, occupation, sex, procedures and methodology limitation. Statistical tool employed to analyze statement of hypothesis was Chi-Square analytical tool to test dependent and in-dependent variables

5.2 Procedure

For effective gamification research, mobile based gamified learning application was implemented to improve to gather learning interest of architecture students in game playing and monitor how it makes it easy for students to learn independently at their own paces. Proposed mobile based gamified learning application development is database driven which intends to follow client/server architecture pattern in design approach. New proposed gamified learning system focuses on using Waterfall Model as major implementation methodology, but will certainly blend prototyping models with it to achieve proposed mobile application for gamified learning that will meet pre-planned objectives. After application development; it was distributed for use among selected students in order to receive feedback through administered pre/post-survey forms. Entire process took six-weeks from planning stage, implementation to research findings. Chi-square was used to measure effectiveness and impact of gamification on architecture students' learning processes to determine user behavioural engagement. It can also be needed when performance of users are to be measured to evaluate impact of game motivation on learning

5.3 Method Employed for Data Collection

This research works on raw data that is dependent on data collection via utilization of secondary and primary information sources. Information was gathered through research questionnaire to collect views, feelings and facts of respondents in architecture department of ATILIM University as it relates to appraisal of existing and new gamification learning system in use and other related issues that are included in primary data collected from student selected respondents and also in secondary data that were collected from internet, journals, textbooks, handbook, magazine and articles on mobile based gamified learning application to improve learning interest of architecture students at ATILIM University

5.4 Certification/Justification of Questionnaire

For adequate justification of questionnaire, researcher ensures that every question asked within the distributed questionnaires is in accordance statement of problem, literature review and research questions on mobile based gamified learning application to improve learning interest of architecture students at ATILIM University before forwarded to supervisor for approval and necessary corrections. Pilot test is used to test instrument, design and method before this research commences initial test of data instrument, collection and processes to identify, minimize and eradicate errors. It is essential to pilot-test instrument in order to ascertain that those questions are well understood by target respondents without ambiguity or wording problems. Pilot testing involves using small-number sample of respondents to test-run appropriateness and comprehension of the questions

First part of questionnaire dealt with student/staff bio-data from respondents in five (5) point-scales ranging from highly certified to highly-uncertified. Two hundred (200) questionnaires will be administered among architecture department students/staffs of ATILIM University in Turkey as part of sampling size employed. Technique proposes for this study is Random-Sampling Method because entire population couldn't be reached individually. Balance will later be made between female and male gender as well as staffs involved

5.5 Method of Data Analysis

Data obtained from questionnaire was correctly analyzed by using statistical tools like frequency (mode), MIS (Mean Item Score) and percentage using existing trusted statistical-tool to analyze, observed-value determine probability differences among expected results. It was also employed to determine homogeneity and independence variables. Proposed statistical-tool was employed to analyze individual question from questionnaire to show extent of opinion and agreement of target respondent on each given question

5.6 Population-Size

Sample-size of one hundred and fifty (150) questionnaires were employed as population-sample size for this gamification study among architectural department students of ATILIM University in Turkey to examine importance of improving learning interest of architecture students through gamified learning application at ATILIM University. Random-sampling technique was employed because it contains extra method that first identifies some characteristics/attributes for random-sampling of entire population

Questionnaires administered	150
Valid returned questionnaires	137
Invalid –questionnaires	13
Total sampling size	150

CHAPTER 6

ANALYSIS OF RESULTS AND DISCUSSION (PRE-SURVEY)

6.1 Pre-Survey Results

This particular chapter is concerned about analysis of research finding presentations based on collected data from respondents via questionnaires, interpretation and hypothesis testing. Data collected was statistically analyzed by utilizing appropriate statistical-formula known as Chi-Square(χ^2) to determine if two population-characteristics are dependent or independent. One hundred and fifty (150) questionnaires were carefully administered to architecture students. However, one hundred and thirty seven (137) were filled and returned while thirteen (13) were either unreturned or invalid. Section-A of distributed questionnaires gathers demographic information of target student/staff respondents like age, educational level, sex and marital status. Other questions were centred on chosen option, expression and perception toward gamified learning based questions using five (5) point-scales employed in construction of questionnaire to capture respondent's options on improving learning interest of architecture students through mobile gamified learning application usages and scales like: unavailable = (3), fairly-adequate = (2), adequate = (1).

Table 6.1: Respondents' Gender Distribution

Categories	Frequency (Freq)	Percentage (%)
Male	104	75.9%
Female	33	24.1%
Total	137	100

Table 6.1 above shows distribution of respondents based on gender, male students constitute 104 (75.9%) of architecture students that filled questionnaire on gamified learning and 33 (24.1%) were female architecture students that filled questionnaire on mobile gamified learning application

Table 6.2: Respondents' Age Distribution

Age	Frequency (Freq)	Percentage (%)
Under 19 yrs	8	5.8%
20-30 yrs	71	51.8%
31-41 yrs	19	13.8%
42-52 yrs	31	22.6%
Above 52 yrs	8	5.8%
Total	137	100

This table 6.2 shows that majority of respondent architecture students were within 20-30 years of age, which make it 51.8% of population under gamified learning consideration, follow by respondents within 42-52 years age group, which are 22.6% of population size that are mostly architecture staffs, and followed by respondents within 31-41years of age group at 13.8%

Table 6.3: Respondents' Marital Status

Status	Frequency (Freq)	Percentage (%)
Single	97	70.8%
Married	22	16.1%
Widowed	14	10.2%
Separated	4	2.9%
Total	137	100%

Table 6.3, shows that majority of target architecture respondents are 97, which form 70.8% of single (never married) respondents because they are majorly students, married respondents are 22, which form 16.1% who are majorly married staffs, 14 among target respondent are widowed that form 10.2% of population-size

Table 6.4: Qualification of Respondents

Qualifications	Frequency(Freq)	Percentage (%)
Doctor (PHD)	28	20.4%

Master's Degree	36	26.3%
BSC	35	25.5%
PGD	13	9.5%
High School	15	10.9%
Others	10	7.4%
Total	137	100%

Table 6.4: This table indicates that 26.3% (36) of target architecture students are master degree holders, 25.5% (35) of respondents were BSC students of architecture, 20.4% (28) respondents were PHD students of architecture while 7.4% (10) were other degree holders from other departments like computer

Table 6.5: Respondent that Like Playing Games

Responses	Frequency (Freq)	Percentage (%)
Yes	86	62.8%
No	31	22.6%
Maybe	20	14.6%
Total	137	100%

Table 6.5 shows that 86 respondents like playing game which forms 62.8% of population-size under considerations, about 31 respondents don't like playing game which forms 22.6% of the population-size while 20 respondents were undecided on whether they play game or not which forms 14.6% of population-size

Table 6.6: Respondents' Platforms used for Playing Games

Responses	Frequency (Freq)	Percentage (%)
Mobile Platform	91	66.4%
Computer Platform	36	26.3%
Game console (PS, XBOX, etc.)	10	7.3%
Total	137	100%

In Table 6.6, 91 respondents play games on mobile platform which forms 66.4% of population-size under considerations, about 36 respondents play computer game on computer system which forms 26.3% of the population-size while 10 respondents play with game consoles which forms 7.3% of population-size

Table 6.7: Respondents Amount of Time Spent Playing Games

Positions	Frequency(Freq)	Percentage (%)
Less than 5 hours per week	15	10.9%
5-10 hours per week	80	58.5%
15-20 hours per week	25	18.2%
More than 20 hours per week	17	12.4%
Total	137	100%

Table 6.7 shows that 80 respondents that are 58.5% spend between five to ten hours every week playing game, 18.2% spend between fifteen to twenty hours playing games among respondents, while about 15 respondents only spend less than five hours playing games on weekly basis which involves 10.9% of population-size

Table 6.8: Respondents Kind of Games they Play

Positions	Frequency(Freq)	Percentage (%)
Strategy games	70	51.1%
Shooting games	15	10.9%
Sports games	20	14.6%
Car games	15	10.9%
Board and card games	17	12.5%
Total	137	100%

Table 6.8 indicates that 70 respondents, which form 51.1% like watching strategy games, 10.9% of respondents like watching shooting and car games, while about 20 respondents like watching sport related games which form 14.6% of population-size

Table 6.9: Respondents' Knowledge and Learning Skill Rating in Playing Games

Positions	Frequency(Freq)	Percentage (%)
Snooker	70	51.1%
Dice game	20	14.6%
Clock Game	22	16.1%
Invader	25	18.2%
Total	137	100%

In Table 6.9, 70 respondents rated themselves good with relevant skill and knowledge in playing games like snooker which form 51.1% of total population-size under considerations, about 25 respondents possess skills and knowledge in playing invaders which forms 18.2% of the population-size while 20 respondents are conversant with playing dice game at 14.6% of population-size

Table 6.10: Respondents Agree or Disagree on Availability of Gamified/e-learning Technology Equipment in your Department for Teaching and Learning Process

Positions	Frequency(Freq)	Percentage (%)
NOT AVAILABLE	50	36.5%
FAIRLY AVAILABLE	20	14.6%
AVAILABLE	67	48.9%
Total	137	100%

In Table 6.10, 67 respondents agreed that **LMS/Online Courses** are learning equipment available for learning in architecture department of ATILIM University, which form 48.9% of population-size. 50 respondents claimed that Gamified Learning is **not available** presently in ATILIM architecture department, which form 36.5% of total population-size under considerations, about 20 respondents support partial availability which forms 14.6% of the population-size

Table 6.11: Respondents that Install Learning Mobile App on His/her Phone

Responses	Frequency (Freq)	Percentage (%)
-----------	------------------	----------------

Yes	100	73.0%
No	17	12.4%
Maybe	20	14.6%
Total	137	100%

Table 6.11 shows that 100 respondents have learning mobile app installed on their phones which forms 73.0% of population-size under considerations, about 17 respondents don't have learning mobile apps installed on their phones, which close at 12.4% of population-size. However, 20 respondents don't know yet if they have mobile app installed or not in their phones

Table 6.12: Respondents Decision on whether Gamification can help Improve Learning Outcome for Architecture Students

Responses	Frequency (Freq)	Percentage (%)
Strongly disagree	52	37.9%
Disagree	5	3.6%
Neutral	5	3.6%
Agree	6	4.3%
Strongly agree	69	50.3%
Total	137	100%

Table 6.12 shows that 69 (50.3%) are parts of majority of student respondents that strongly agreed that gamification can help improve learning outcome for architecture students, 52 (37.9%) strongly disagreed that gamification can help improve learning outcome for architecture students

Table 6.13: Respondents that Responded on Existing mode of Learning used to Teach Students of Architecture Department at ATILIM University

Responses	Frequency (Freq)	Percentage (%)
Face-to-face	97	70.8%
Online Learning	30	21.9%

Blended learning	10	7.3%
Total	137	100%

Table 6.13 shows that 97 respondents confirmed that existing learning mode in use to teach architecture students at ATILIM is based on face-to-face conventional learning system which forms 70.8% of population-size under considerations, about 30 respondents confirmed existence of online learning which forms 21.9% of population-size. About 10 (7.3%) confirmed existence of blended learning in the department

Table 6.14: Respondents Confirmation on Barrier against Adopting Gamification for Learning in Architecture Department

Positions	Frequency(Freq)	Percentage (%)
Lack of Knowledge on implementing it	65	47.4%
Cost of Implementation is expensive	50	36.5%
Unsure of how to measure its effectiveness	5	03.7%
Others	17	12.4%
Total	137	100%

Table 6.14 shows that 65 respondents affirmed that major barrier against adopting gamification for learning in architecture department are lack of knowledge to implement it which accounted for 47.4% of population-size. 50 respondents affirmed that barrier against adopting gamification for learning in architecture department is due to high-cost of implementation which accounted for 36.5% of population-size. However, 3.7% (5) were unsure on how to measure the barrier metrics.

Hi: Gamification can help Improve Learning Outcome for Architecture Students

CONTINGENCY TABLE ONE, Using question 6.12

Responses	O	E	O-E	(O-E) ²	$\frac{(O-E)^2}{E}$
Strongly disagree	52	27.4	24.6	605.2	22.1
Disagree	5	27.4	-22.4	501.8	18.3
Neutral	5	27.4	-22.4	501.8	18.3
Agree	6	27.4	-21.4	458.0	16.7
Strongly agree	69	27.4	41.6	1730.6	63.2
Total	137				138.6

	Value	Degree-of-freedom (df)	level of significance
Person Chi square	138.6	4	0.05
No of Valid Case	137		

The P-Value is < .00001. The result is significant at $p < .05$.

Where O = Observed

E = Expected

Using Chi-Square, relative hypotheses were carefully compared with observed frequency.

Note: value of expected (E) is related by dividing sample-space by remaining categories thus, $137/5 = 27.4$

$X^2 c =$ calculated-value

$X^2 t =$ tabulated-value

$X^2 c = 138.6$

Degree of freedom depends on number of constraints imposed on data for contingency table having columns (c) and row (r) degrees of freedom given by: $(r-1)(c-1)$

Here, with two (2) rows and five (5) columns.

Therefore: $(2-1)(5-1) = (1)(4) = 4$; which implies that degree-of-freedom is 4.

Checking table for value of 0.05 levels of significance; we have 9.488. This gives $X^2 t$ value as 9.488 (from table)

Decision Rule

We reject null-hypothesis of independence at 0.05 level of significance; if calculated value of test-statistic exceeds critical tabulated of χ^2 for (r-1) (c-1) degree-of-freedom.

Decision

Since χ^2 -calculated value (χ^2_c) is 138.6, which seems greater than χ^2 -tabulated value (χ^2_t) at 9.488/0.05 level of significance. Here, null-hypothesis is rejected while research hypothesis “Gamification can help Improve Learning Outcome for Architecture Students of ATILIM University” is accepted. This implies that Gamification can improve learning outcome of architecture students

HYPOTHESIS TWO-USING question 6.14

Hi: Barrier can serve as obstacles against Adopting Gamification for Learning in Architecture Department

CONTINGENCY TABLE TWO (2) Using question 6.14

Responses	O	E	O-E	(O-E) ²	$\frac{(O-E)^2}{E}$
Lack of Knowledge on implementing it	65	34.3	30.7	942.5	27.5
Cost of Implementation is expensive	50	34.3	15.4	237.2	6.9
Unsure of how to measure its effectiveness	5	34.3	-29.3	858.5	25.0
Other	17	34.3	-17.3	299.3	8.7
Total	137				68.1

	Value	Degree-of-freedom (df)	level of significance
Person Chi square	68.1	4	0.05
No of Valid Case	137		

The P-Value is < .00001. The result is significant at $p < .05$.

Where H_0 is null-hypothesis, H_1 is research-hypothesis.

Note: expected value (E) is expressed by dividing sample-space with categories thus:

$$137/4 = 34.25 = 34.3$$

Decision Rule

When calculated value of test-statistic exceeds critical-level (tabulated) at appropriate level-of- significance and degree-of-freedom, research hypothesis must be rejected. Calculated value is 68.1, which is greater than value gotten from tabulated value at 9.488 on 0.05 level-of- significance and freedom.

Decision

Since computed value is 68. 1, which is higher than tabulated-value 9.488 at 0.05 level-of- significance and degree of freedom at 4; null-hypothesis is thereby rejected while accepting the fact that “Barrier can serve as obstacles against adopting gamification for learning in architecture at ATILIM University“. This implies that every obstacle against improvement of gamification to improve learning in architecture at ATILIM University must be overcome

CHAPTER 7

ANALYSIS OF RESULTS AND DISCUSSION (POST-SURVEY)

7.1 Post-Survey Results

This chapter is dedicated to post-survey analysis of implemented application based on collected data from respondents via questionnaires, interpretation and hypothesis testing. Data collected on application feedback was statistically analyzed using Chi-Square(χ^2) to determine if two population-characteristics are dependent or independent. One hundred and fifty (150) questionnaires were carefully administered to architecture students that helped out in the pre-survey information gathering. However, one hundred and thirty seven (137) forms were filled and returned while thirteen (13) were either unreturned or invalid. Section-A of distributed questionnaires gathers demographic information of target student/staff respondents like age, educational level, sex and marital status. Other questions were centred on chosen option, expression and perception toward gamified learning based questions using five (5) point-scales employed in construction of questionnaire to capture respondent's options on mobile gamified application that has capability to improve learning interest of architecture students. Scales used are: unavailable = (3), fairly-adequate = (2), adequate = (1).

7.2 Population-Size

Sample-size of one hundred and fifty (150) questionnaires were employed as population-sample size for this gamification study among architectural department students of ATILIM University in Turkey to examine how gamified learning application implemented can improve learning interest of architecture students in ATILIM University. Random-sampling technique was employed after application implementation because it contains extra method that first identifies some characteristics/attributes for random-sampling of entire population

Questionnaires administered	150
Valid returned questionnaires	137
Invalid -questionnaires	13
Total sampling size	150

Table 7.1: Respondents' Gender Distribution

Categories	Frequency (Freq)	Percentage (%)
Male	104	75.9%
Female	33	24.1%
Total	137	100

Table 7.1 shows distribution of respondents based on gender, male students constitute 104 (75.9%) of architecture students that filled post-questionnaire on gamified learning and 33 (24.1%) were female architecture students that filled post-questionnaire on mobile gamified learning application

Table 7.2: Respondents' Age Distribution

Age	Frequency (Freq)	Percentage (%)
Under 19 yrs	8	5.8%
20-30 yrs	71	51.8%
31-41 yrs	19	13.8%
42-52 yrs	31	22.6%
Above 52 yrs	8	5.8%
Total	137	100

This table 7.2 shows that majority of respondent architecture students were within 20-30 years of age, which make it 51.8% of population under gamified learning consideration, follow by respondents within 42-52 years age group, which are 22.6% of population size that are mostly architecture staffs, and followed by respondents within 31-41years of age group at 13.8%

Table 7.3: Respondents' Marital Status

Status	Frequency (Freq)	Percentage (%)
Single	97	70.8%

Married	22	16.1%
Widowed	14	10.2%
Separated	4	2.9%
Total	137	100%

Table 7.3, shows that majority of target architecture respondents are 97, which form 70.8% of single (never married) respondents because they are majorly students, married respondents are 22, which form 16.1% who are majorly married staffs, 14 among target respondent are widowed that form 10.2% of population-size

Table 7.4: Qualification of Respondents

Qualifications	Frequency(Freq)	Percentage (%)
Doctor (PHD)	28	20.4%
Master's Degree	36	26.3%
BSC	35	25.5%
PGD	13	9.5%
High School	15	10.9%
Others	10	7.4%
Total	137	100%

Table 7.4: This table indicates that 26.3% (36) of target architecture students are master degree holders, 25.5% (35) of respondents were BSC students of architecture, 20.4% (28) respondents were PHD students of architecture while 7.4% (10) were other degree holders from other departments like computer

Table 7.5: Respondent that Participate in Pre-Test

Responses	Frequency (Freq)	Percentage (%)
Yes	116	84.7%
No	21	15.3%
Total	137	100%

Table 7.5 shows that 116 respondents participated in Pre-Test which forms 84.7% of population-size under considerations, about 21 respondents did not participate in Pre-Test which forms 15.3% of the population-size

Table 7.6: Respondents Decision on whether Blended learning is preferred to Traditional learning for Architecture Students

Responses	Frequency (Freq)	Percentage (%)
Strongly disagree	22	16.2%
Disagree	5	3.6%
Neutral	5	3.6%
Agree	6	4.3%
Strongly agree	99	72.3%
Total	137	100%

Table 7.6 shows that 69 (72.3%) are parts of majority of student respondents that strongly agreed that blended learning is preferred to traditional learning for architecture students, 22 (16.2%) strongly disagreed that blended learning is preferred to traditional learning for architecture students

Table 7.7: Respondents decision on whether Gamified learning management mobile app enhances my learning ability of Architecture

Responses	Frequency (Freq)	Percentage (%)
Strongly disagree	12	8.9%
Disagree	5	3.6%
Neutral	5	3.6%
Agree	6	4.3%
Strongly agree	109	79.6%
Total	137	100%

Table 7.7 shows that 109 (79.6%) are parts of majority of student respondents that strongly agreed that gamification learning management mobile app enhances learning ability of Architecture students, 12 (8.9%) strongly disagreed that

gamification learning management mobile app enhances learning ability of Architecture students

Table 7.8: Respondents decision on whether Gamified learning management mobile app was an effective motivating learning process of Architecture

Responses	Frequency (Freq)	Percentage (%)
Strongly disagree	20	14.6%
Disagree	5	3.7%
Neutral	5	3.7%
Agree	6	4.3%
Strongly agree	101	73.7%
Total	137	100%

Table 7.8 shows that 101 (73.7%) are parts of majority of student respondents that strongly agreed that Gamified learning management mobile app was effective in motivating learning process of Architecture students, 20 (14.6%) strongly disagreed that gamified learning management mobile app was effective in motivating learning process of Architecture students

Table 7.9: Respondents decision on whether my attention and engagement in the lessons were enhanced with Gamified learning management mobile app

Responses	Frequency (Freq)	Percentage (%)
Strongly disagree	15	11%
Disagree	5	3.6%
Neutral	5	3.6%
Agree	6	4.4%
Strongly agree	106	77.4%
Total	137	100%

Table 7.9 shows that 106 (77.4%) are parts of majority of student respondents that strongly agreed that gamified learning app lessons enhanced attention and

engagement of users to improve learning outcome, 15 (11%) strongly disagreed that gamified learning app lessons enhanced attention and engagement of users

Table 7.10: Respondents describes effort at learning with Gamified learning management mobile app

Responses	Frequency (Freq)	Percentage (%)
Good	91	66.4%
Fair	36	26.3%
Poor	10	7.3%
Total	137	100%

In Table 7.10, 91 respondents describes effort at learning with Gamified learning management mobile app as good which forms 66.4% of population-size under considerations, about 36 respondents responded as fair which forms 26.3% of the population-size while 10 respondents responded that effort at learning with Gamified learning management mobile app as poor which forms 7.3% of population-size

Table 7.11: Respondents decision on whether architecture department should adopt the Gamified learning management mobile app?

Responses	Frequency (Freq)	Percentage (%)
Strongly disagree	12	8.9%
Disagree	5	3.6%
Neutral	5	3.6%
Agree	6	4.3%
Strongly agree	109	79.6%
Total	137	100%

Table 7.11 shows that 109 (79.6%) are parts of majority of student respondents that strongly agreed that architecture department should adopt Gamified learning management mobile app to improve outcome of learning, 12 (8.9%) strongly disagreed that architecture department should adopt Gamified learning management mobile app

Hi: Gamification can be effective in motivating learning process

CONTINGENCY TABLE ONE, Using question 7.8

Responses	O	E	O-E	(O-E) ²	$\frac{(O-E)^2}{E}$
Strongly disagree	20	27.4	-7.4	54.8	2.0
Disagree	5	27.4	-22.4	501.8	18.3
Neutral	5	27.4	-22.4	501.8	18.3
Agree	6	27.4	-21.4	458.0	16.7
Strongly agree	101	27.4	73.6	5417	198
Total	137				253.3

	Value	Degree-of-freedom (df)	level of significance
Person Chi square	253.3	4	0.05
No of Valid Case	137		

The P-Value is < .00001. The result is significant at $p < .05$.

Where O = Observed

E = Expected

Using Chi-Square, relative hypotheses were carefully compared with observed frequency.

Note: value of expected (E) is related by dividing sample-space by remaining categories thus, $137/5 = 27.4$

$X^2 c$ = calculated-value

$X^2 t$ = tabulated-value

$X^2 c = 253.3$

Degree of freedom depends on number of constraints imposed on data for contingency table having columns (c) and row (r) degrees of freedom given by: $(r-1)(c-1)$

Here, with two (2) rows and five (5) columns.

Therefore: $(2-1)(5-1) = (1)(4) = 4$; which implies that degree-of-freedom is 4.

Checking table for value of 0.05 levels of significance; we have 9.488. This gives X-tabulated (X^2_t) value as 9.488 (from table)

Decision Rule

We reject null-hypothesis of independence at 0.05 level of significance; if calculated value of test-statistic exceeds critical tabulated of X^2 for (r-1) (c-1) degree-of-freedom.

Decision

Since X-calculated value (X^2_c) is 253.3, which seems greater than X-tabulated value (X^2_t) at 9.488/0.05 level of significance. Here, null-hypothesis is rejected while research hypothesis “Gamification can help Improve Learning Outcome for Architecture Students of ATILIM University” is accepted. This implies that Gamification can improve learning outcome of architecture students

HYPOTHESIS TWO-USING question 7.11

Hi: Architecture department should adopt Gamified learning management mobile app to enhance education

CONTINGENCY TABLE TWO (2) Using question 7.11

Responses	O	E	O-E	(O-E) ²	<u>(O-E)²</u> E
Strongly disagree	12	27.4	-15.4	237.2	8.7
Disagree	3	27.4	-24.4	595.4	21.7
Neutral	6	27.4	-21.4	458	16.7
Agree	7	27.4	-20.4	416.2	15.2
Strongly Agree	109	27.4	81.6	6658.6	243
Total	137				305.3

	Value	Degree-of-freedom (df)	level of significance
Person Chi square	253.3	4	0.05
No of Valid Case	137		

The P-Value is < .00001. The result is significant at p < .05.

Where H_0 is null-hypothesis, H_1 is research-hypothesis.

Note: expected value (E) is expressed by dividing sample-space with categories thus:

$$137/5 = 27.4$$

Decision Rule

When calculated value of test-statistic exceeds critical-level (tabulated) at appropriate level-of- significance and degree-of-freedom, research hypothesis must be rejected. Calculated value is 305.3, which is greater than value gotten from tabulated value at 9.488 on 0.05 level-of- significance and freedom.

Decision

Since computed value is 305.3, which is higher than tabulated-value 9.488 at 0.05 level-of- significance and degree of freedom at 4; null-hypothesis is thereby rejected while accepting the fact that “Architecture department supports adopting gamified learning management mobile app to enhance education at ATILIM University“. This implies that mobile application like this should be developed to improve education at ATILIM University

Summary Discussion with Related Literature

Literature review of gamified learning and its effects on architecture students showed that, in general; gamified learning can help to boost interest of architecture students. Compared to traditional learning methods in literature review, mobile based gamified learning can help to increase student engagement, motivation and engagement. When compared to conventional learning methods in literature review, new developed mobile gamified learning system can help to decrease anxiety and boredom while providing more enjoyable learning experiences. Literature reviews have shown that if gamified learning system is implemented correctly, it can be effective in helping students to learn more quickly and effectively as well as boost student interest in subject matter. Overall, results from literature review are consistent with results gotten from new mobile gamified learning study conducted with architecture students which indicates that gamified learning can become effective way to boost interest in architecture

CHAPTER 8

SUMMARY, RECOMMENDATION AND CONCLUSION

8.1 Summary

Development of life-cycle routine for mobile based gamified learning system to improve learning interest of architecture student started from groundwork stage to implementation, testing and deployment stages. Detail examination of this project implementation has proved that every preliminary aim and objectives have been successfully accomplished. Research on mobile based gamified learning system has been accomplished because it has been able to achieve predefined set objectives after careful implementation; testing, review and deployment were performed:

- i. It helps to resolve problem interrelated to traditional learning system in use at ATILIM University, architecture department
- ii. It helps in making mobile based gamified learning content accessible from any worldwide location irrespective of student's location
- iii. It helps to generate useful academic statistics of online visitors which will assist future academic planning and development
- iv. It has enhanced security because it is password protected to keep virtual classroom database always secured
- v. This system serves as prototype for other institutions to set up virtual classroom website for their part-time academic program

8.2 Problem Encountered

Problem encountered during implementation and deployments of mobile based gamified learning system to improve learning interest of architecture student are:

- i. **Out-of-Stock Literature Sources:** Looking at this research topic seems simple, but to be candid; useful research materials on this topic area is scarce and difficult to get. It requires diligence and creative analytical mind to get this project implemented
- ii. **Programming-Logic:** Logic adopted to handle programming section for this research caused issues that took days before it could be resolved before final

deployment began. For example, database (MySQL) connectivity problems posed scores of challenges

- iii. **Lack of Adequate Funding:** Without financial commitment to pay for computer time and typesetting, this application design and implementation will never be tagged successful; purchasing browsing data for computer and mobile phone for intensive research purposes also involved their financial commitments

8.3 Further Research

This work requires improvement in future research; server for mobile based gamified learning system to improve learning interest of architecture student is presently setup in local domain via wampserver/laragon; however, in nearby future; ATILIM University, architecture department should host this application on dedicated live-server to enhance improved hosting security and effectiveness. To cause progress to occur to mobile based gamified learning system in future development; below are areas of future focuses:

- i. Implementation of gamified learning application for window mobile, IOS and desktop independent versions will be required in future research because new proposed gamified system is based on mobile android platform
- ii. GUI-Graphical-User-Interface in this application needs to get improved upon in future gamified learning development
- iii. Security provision for new gamified learning system to improve learning interest of architecture student can never be found enough; future gamified learning implementation must incorporate strong security feature in future application development to restrict access permission to individual learning resources where necessary
- iv. Advanced data mining of application information users of mobile based gamified learning system should be collected for future academic planning purposes to further improve learning interest of architecture student

8.4 Recommendation

Successful models employed for implementing mobile based gamified learning system to improve learning interest of architecture student must be sustained or built upon in nearest future. Policy implications on application development must be

weighed before embarking on implementation of mobile gamified learning for quality academic practice and curriculum development. Many other recommendations below must be noted:

- i. Hardware equipment for server hosting employed for mobile based gamified learning system to improve learning interest of architecture student must be secured against external/internal attackers to avoid unnecessary downtimes
- ii. Every academic stakeholder and enthusiast involved in mobile based gamified learning system must collaborate to incorporate this new application to effect expected changes that will support ATILIM University to achieve its academic excellence to improve learning interest of its architecture student
- iii. Development of mobile based gamified learning application for ATILIM University must be considered in nearby future implementation
- iv. ATILIM University must source for new technology to streamline academic output and improve on this mobile based gamified learning application to avoid reliance on traditional face-to-face classroom as currently practice
- v. ATILIM University management must handover this new mobile based gamified learning application development to her IT-staffs for constant monitoring to achieve better outcome that will lead to improvement of learning interest among architecture students

8.5 Conclusion

Gamification of mobile learning in emerging educational scheme is dependent on practical integration, deployment and classroom application before it can be tagged successful and contributes to improvement of learning interest among architecture students. Common gamification among students that is capable of improving interest of students must inculcate use of reward and point to motivate architectural students in non-gaming context. Concept behind gamification has been in existence before video game came into being but its focus was not really on education. Gamification management can offer safe and inclusive learning environment in interactive and entertaining manners that will encourage architectural students to learn with keen interest in gamified manner at their own paces. Mobile based gamified learning is becoming more popular among architecture students to improve interest and attitude toward academic learning. Mobile based gamified learning system to improve

learning interest of architecture student has come to stay to add interactive and entertaining feature to modern digital learning environment. Mobile gamified learning has never been introduced to get rid of traditional face-to-face classroom completely; but comes to offer complementary role to strengthen existing system of education in use presently at ATILIM University.

Mobile gamified learning offers some people opportunities to have access to education from any location due to its flexibility to fit individual learning curve. It has been found useful in architecture learning especially during Covid-19 global pandemic where students are forced out of conventional classrooms to seek learning via mobile gamified learning system. During this period; mobile based gamified learning system replaced many conventional classrooms in many countries due to diverse restrictions imposed on traditional classrooms through social distancing and reduction in numbers of students that must sit together inside conventional classroom to prevent spread of corona virus. However, despite daily steady improvement in mobile gamified learning system and its usefulness to improve learning interest of architecture student in contemporary academic environment, there are still some challenges that require resolution if mobile gamified learning system becomes more widely accepted.

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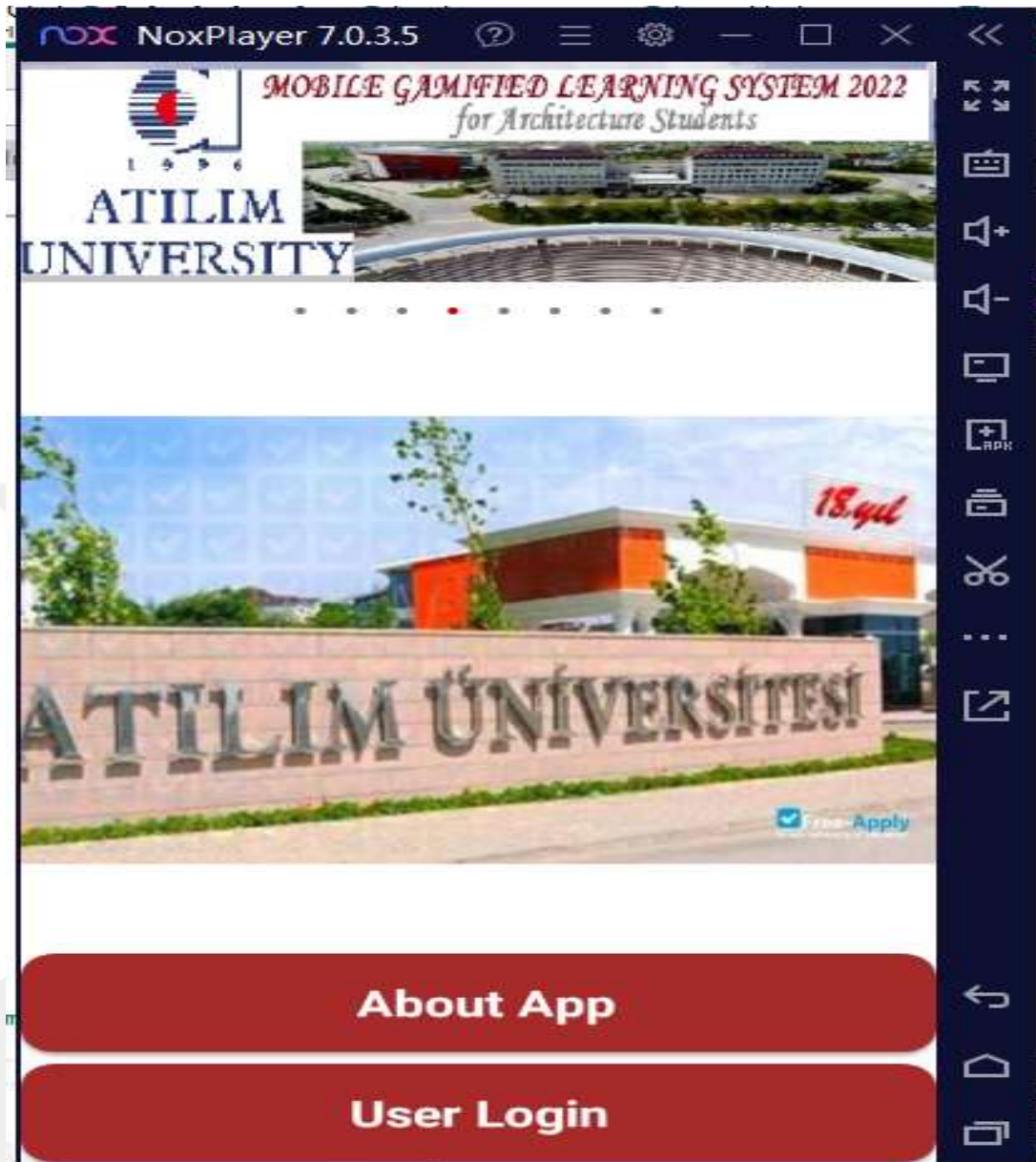
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APPENDIX A (PROGRAM INTERFACE)


Front-Page: This is front page of mobile gamified learning system to improve student learning where architecture student can login to learn about architecture




Login Page: This is where student/user inputs his/her username and password to login into gamified learning application to learn


NoxPlayer 7.0.3.5 8:00

About Gamified Learning

 *MOBILE GAMIFIED LEARNING SYSTEM 2022
for Architecture Students*



**ATILIM
UNIVERSITY**


1 9 9 6

**ATILIM
UNIVERSITY**

username here

password here

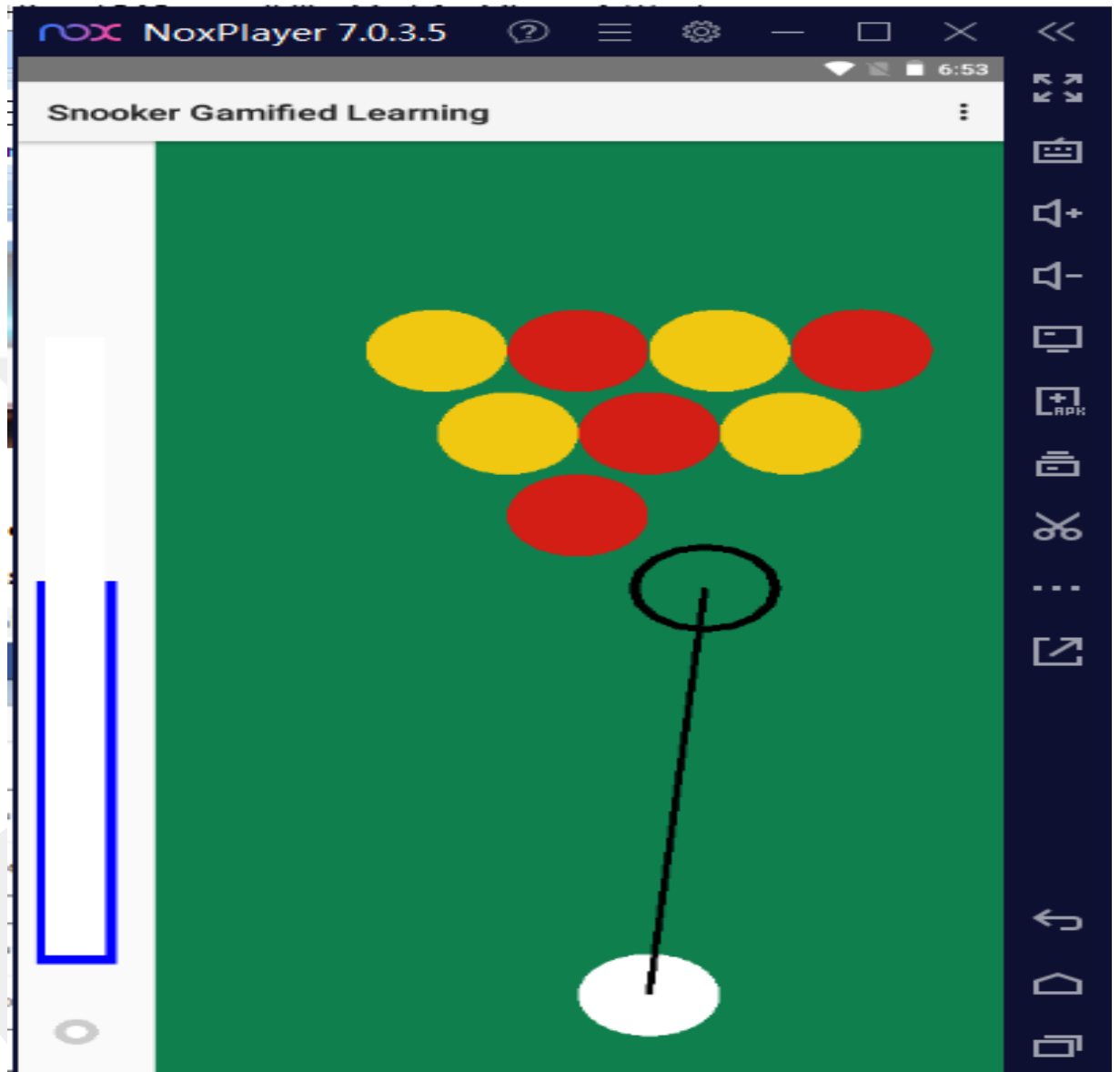
USER LOGIN

Call Us **Email Us**

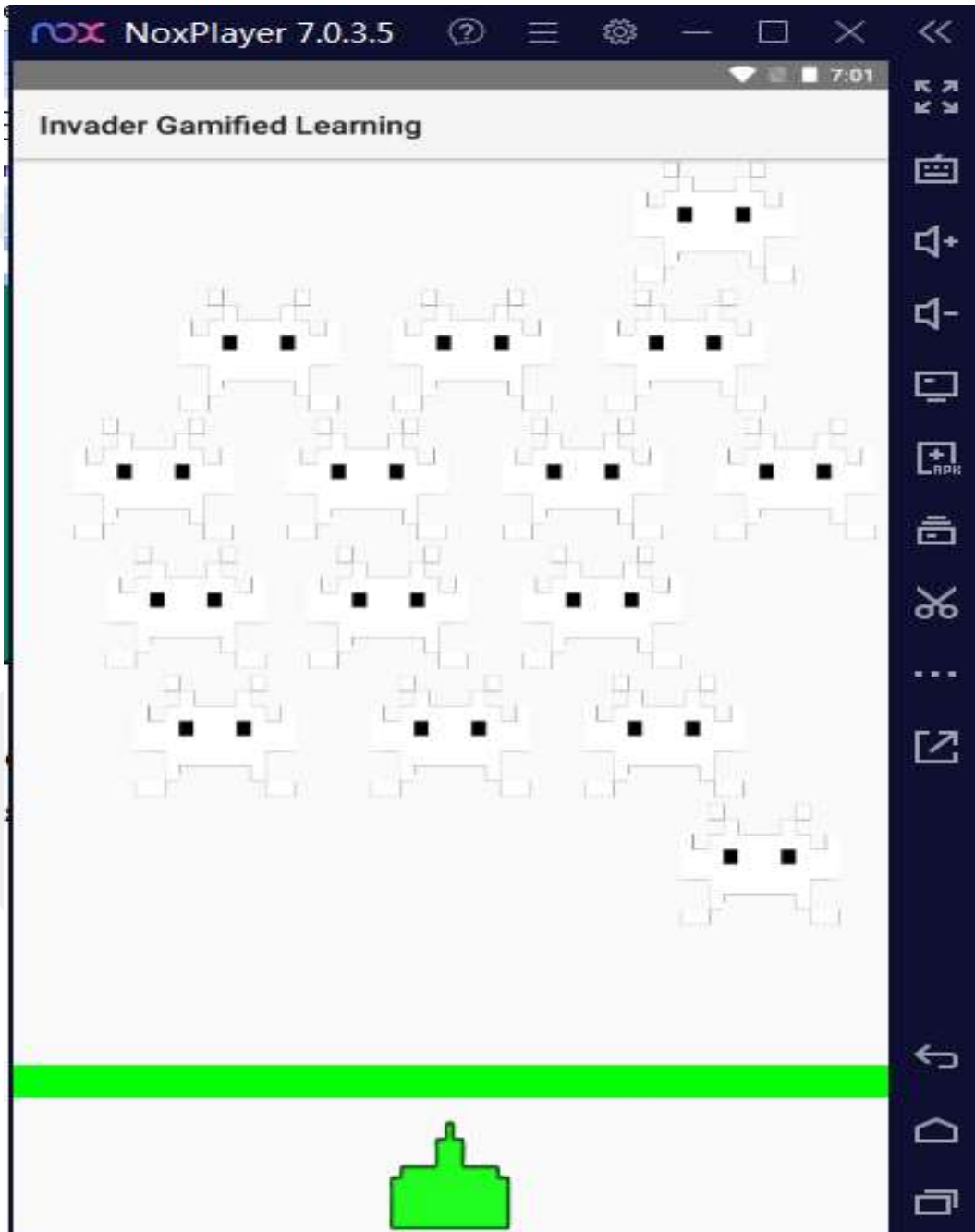
About Page: This is a page that showcases what the app is all about; it shows better on real device that using emulator like this



Snooker Gamified Learning Page: This page is where student plays snooker game by hitting each of the balls which actually represented academic content in video, text, audio, animation and more formats. He/she can increase on level difficulty by increasing number of balls from the application



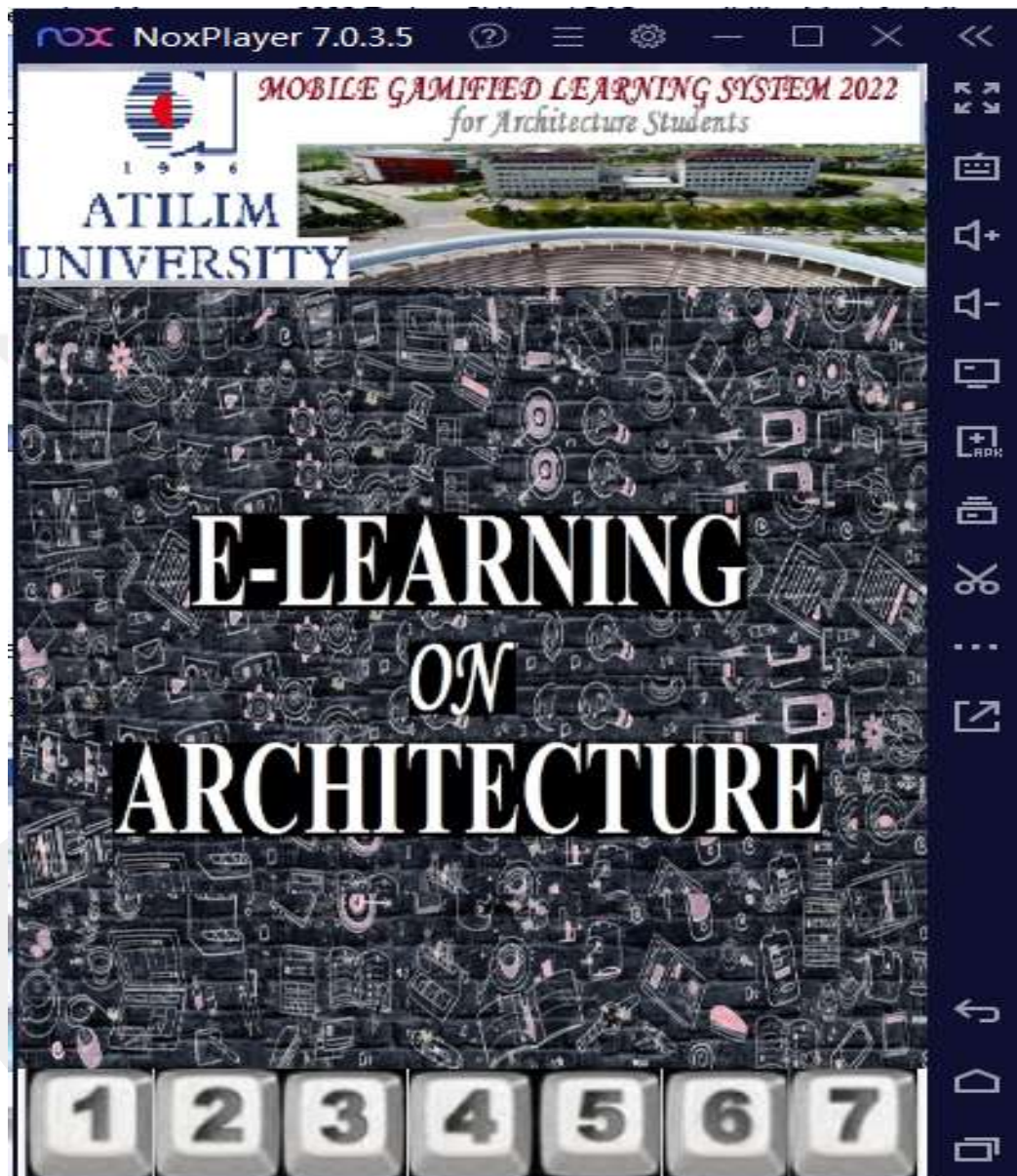
Invader Gamified Learning Page: This page is where student plays invader game by preventing aliens from invading earth where he/she resides and schooling. Each student player has allocated bullets which he/she can use to fire invaders/aliens as they want to invade the earth and disturb his/her academic. After winning the war, he/she is rewarded or not rewarded with academic content to in video, text, audio, animation and more formats




Advice Page: This shows other way of motivating student to learning by allowing prof. Robot to give advice to architecture students which may end up improving their interest in learning



Gamified Tutorial Learning: In this page, e-learning content is gamified; each button when clicked can present video, audio, animation, images and html document to students. Clicking each button multiple times can present different media type on architecture which motivates students to learn more when presented in multimedia format



Gamified Text Format: In this page, gamified e-learning content is presented as text document for students to learn; clicking the same button can present content in video, audio, animation, images and more multimedia format



The screenshot shows a mobile application interface for architecture students. At the top, there is a header with the text "MOBILE GAMIFIED LEARNING SYSTEM 2022 for Architecture Students" and the Atılım University logo. Below the header is a large image of a modern architectural building. The main content area is titled "What Is Architecture Design?" and contains a paragraph defining architecture as the discipline of designing and building structures that meet functional and aesthetic requirements. It also lists three characteristics that differentiate architecture from other structures: human interaction, permanence, and well-designed form. At the bottom of the screen, there is a row of seven numbered buttons (1-7) and a navigation bar with various icons.

MOBILE GAMIFIED LEARNING SYSTEM 2022
for Architecture Students

ATILIM UNIVERSITY

What Is Architecture Design?

Architecture is the discipline of designing and building a range of structures that are used to meet both functional and aesthetic requirements. Since every culture has a unique relationship with the natural world and with the other cultures around them, the structures it creates convey a great deal about its traditions, history, environment, artistic sensibilities, and many other facets of everyday life.

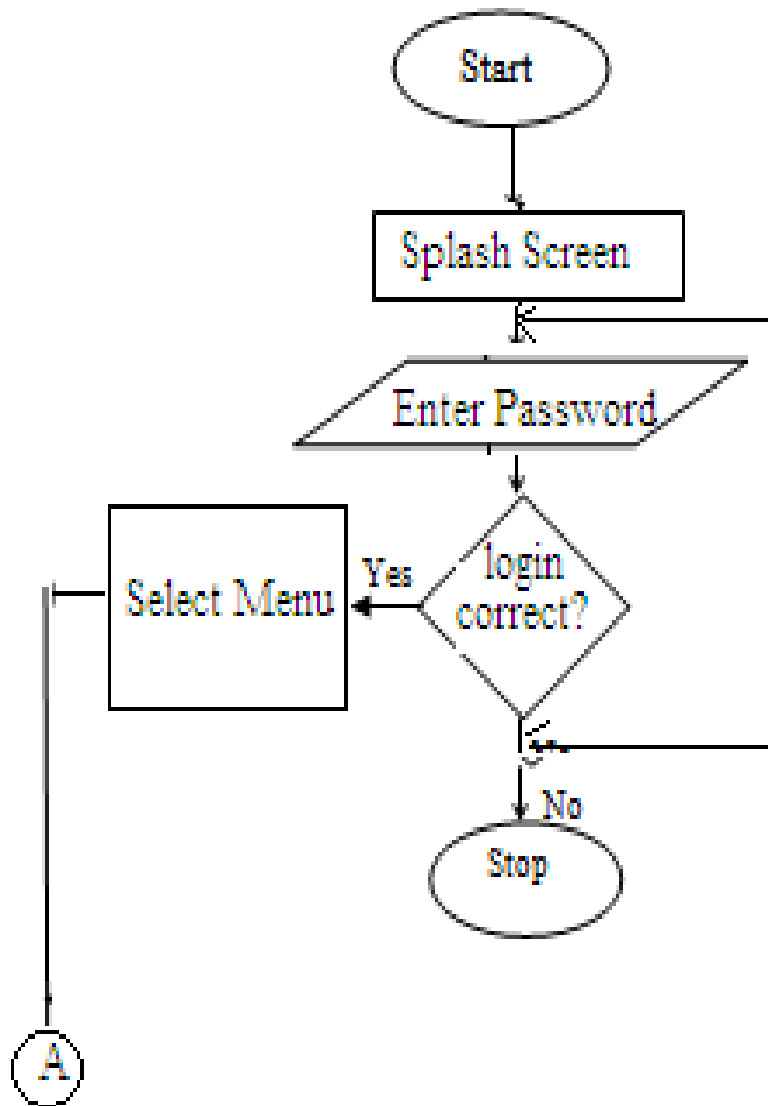
There are three characteristics that differentiate architecture from other structures that have been built according to the architecture definition:

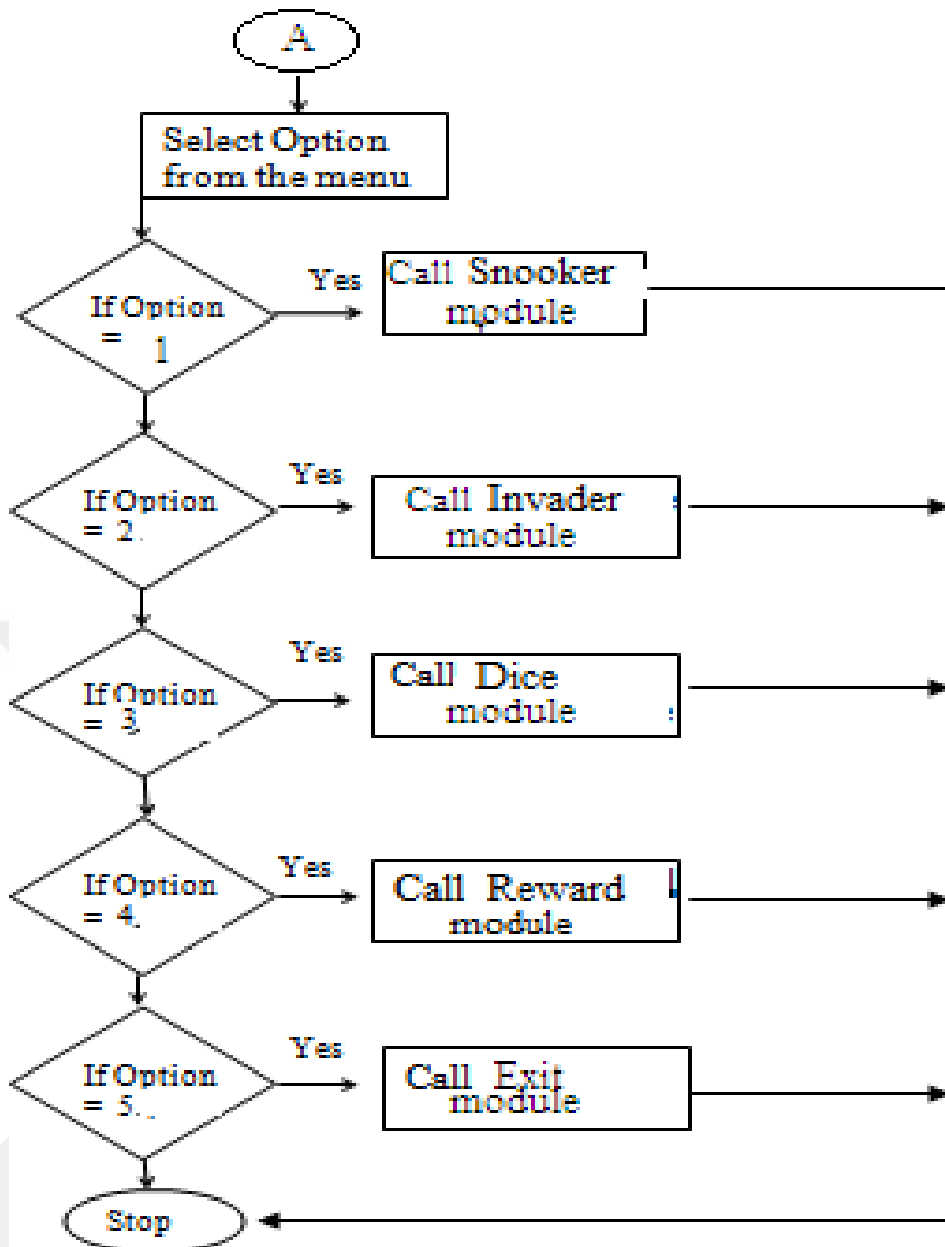
- The structure is created with **human interaction** in mind.
- The structure is intended to be **permanent** and **well-designed**.
- Its form should convey a **specific idea** or

Gamified Video Format: In this page, gamified e-learning content is presented as video for students to learn; clicking the same button can present content in text/html, audio, animation, images and more multimedia format



APPENDIX B (PROGRAM FLOWCHART)





APPENDIX C (PRE-SURVEY FORM/QUESTIONNAIRE)



**ANKARA, TURKEY
QUESTIONNAIRE/SURVEY FORM**

Dear Respondent,

This questionnaire is designed to gather data for application development in partial fulfilment of MSC in Computer Engineering. The study aims at gathering data required for implementation of mobile based gamified learning management system to improve learning interest for architecture students at ATILIM University. Please, you are requested to kindly respond to these questions to the best of your knowledge and tick where appropriate. Any information provided will be treated confidentially and will only be used for academic purposes.

Thank you!

SECTION A: DEMOGRAPHIC DATA

(GENERAL RESPONSE REQUIRED FOR SECTION B TO D)

Please provide information regarding yourself; by ticking the appropriate boxes.

- 1) Your gender (a) Male b) Female
- 2) What age group do you belong to? (a) Below 19 b) 20-40 c) 40 - 60 d) 60 above

- 3) Highest Level of education? (a) Doctorate (Ph.D.) [] b) Master's degree [] (c) Bachelor's Degree [] (d) Other []
- 4) Are you a student or staff of ATILIM University?
 a) I'm a student [] b) I'm a staff [] c) (C) Not Applicable []
- 5) What is your department or course of study?

SECTION B: ABILITIES OF USING COMPUTER EQUIPMENT

- Do you like playing games? (Yes / No / Maybe)
- What is the platform you use for playing games? (a) Mobile games (b) computer Games (c) game console (PS, XBOX, etc.)
- How much time do you spend playing games on average (a) Less than 5 hours per week (b) 5-10 hours per week (c) 15-20 hours per week (d) More than 20 hours per week
- What kind of games do you play usually (a) strategy games (b) shooting games (c) sports games (d) Car games (e) Board and card games
- How do you rate your knowledge and learning skills to play the following games below:

ICT EQUIPMENT	VERY POOR	POOR	FAIR	GOOD	VERY GOOD
Snooker					
Dice game					
Clock Game					
Invader					

SECTION C: AVAILABILITY OF GAMIFIED/E-LEARNING TECHNOLOGIES

How do you agree or disagree on the availability of following gamified/e-learning technology equipment in your architecture department for teaching and learning process?

GAMIFIED/E-LEARNING EQUIPMENT	NOT AVAILABLE	FAIRLY AVAILABLE	AVAILABLE
Virtual Classroom			
LMS/Online Courses			
Video Training			
Gamified Learning			
Social Learning			
Virtual Reality			
Mobile Learning			
Blended Learning			

SECTION D: PERCEPTION ON BLENDED LEARNING & GAMIFICATION

- How strongly do you agree that gamification can help improve learning outcome for architecture students in your department?
 - Strongly Disagree []
 - Disagree []
 - Neutral []
 - Strongly Agree []
 - Agree []
- What is the existing mode of learning used to teach students of architecture department?
 - Face-to-face Classroom learning []
 - Online Learning []
 - Blended learning []
 - Once in a while []

3. I would like to install a Learning Mobile app on my phone. (Yes / No/ Maybe)

4. What is the barrier against adopting gamification for learning in your architecture department? (a) Lack of Knowledge on implementing it [] b) Cost of Implementation is expensive [] c) Unsure of how to measure its effectiveness [] d) Others []

5. In your own opinion, what do you regard as the biggest challenge affecting students' performance in handling gamified/e-learning equipment in your architecture department?

.....

APPENDIX D (POST-FEEDBACK FORM/QUESTIONNAIRE)



APPLICATION ASSESSMENT FEEDBACK FORM

Dear Respondent,

This questionnaire is designed to gather feedback data for implemented and developed gamified applications in partial fulfillment of MSC in Computer Engineering. The study aims at gathering assessment feedback data required for the final deployment of a mobile-based gamified learning management system to improve the learning interest of architecture students at Atilim University. Please, you are requested to kindly respond to these evaluation questions to the best of your knowledge and tick where appropriate. Any information provided will be treated confidentially, and will only be used for academic purposes.

Thank you!

SECTION A:

DEMOGRAPHIC DATA

(GENERAL RESPONSE REQUIRED FOR SECTION)

Please provide information regarding yourself; by ticking the appropriate boxes.

- 6) Your gender (a) Male [] b) Female []
- 7) What age group do you belong to? (a) Below 19 [] b) 20-40 []
c) 40 - 60 [] d) 60 above [] e) Above 52 []

- 8) Highest Level of education? (a) Doctorate (Ph.D.) [] b) Master's degree [] (c) Bachelor's Degree [] (d) Other []
- 9) Are you a student or staff of Atilim University?
 b) I'm a student [] b) I'm a staff [] c) (C) Not Applicable []
- 10) What is your department or course of study?

- 11) Did you participate in filling out the first survey (Pre Test) form while gathering data for gamification development? (a) Yes [] (b) No []

SECTION B: ASSESSMENT OF GAMIFIED/E-LEARNING APPLICATION

1. I prefer blended learning to traditional learning (a) Strongly Disagree [] b) Disagree [] c) Neutral [] d) Strongly Agree [] e) Agree []
2. Gamified learning management mobile app enhances my learning ability (a) Strongly Disagree [] b) Disagree [] c) Neutral [] d) Strongly Agree [] e) Agree []
3. The Gamified learning management mobile app was an effective motivating learning process. (a) Strongly Disagree [] b) Disagree [] c) Neutral [] d) Strongly Agree [] e) Agree []
4. My attention and engagement in the lesson were enhanced with Gamified learning management mobile app (a) Strongly Disagree [] b) Disagree [] c) Neutral [] d) Strongly Agree [] e) Agree []
5. Describe your effort learning with the Gamified learning management mobile app (a) Good [] b) Fair [] c) Poor []

6. Do you think the architecture department should adopt the Gamified learning management mobile app? (a) Strongly Disagree [] b) Disagree [] c) Neutral [] d) Strongly Agree [] e) Agree []

APPENDIX E (PROGRAM SOURCE-CODE)

```
#Region Activity Attributes
```

```
    #FullScreen: False
```

```
    #IncludeTitle: True
```

```
#End Region
```

Sub Process_Globals

```
'These global variables will be declared once when the application starts.
```

```
'These variables can be accessed from all modules.
```

```
Dim time As Timer
```

```
Dim awake As PhoneWakeState
```

```
Dim FRICTION As Float ' friction of the balls
```

```
Dim BALL_MASS As Float ' weight of the balls
```

```
Dim BALL_RADIUS As Float ' radius of the balls
```

```
Dim BALL_DIAMETER As Float ' diameter of the balls
```

```
Dim NUMBALLS As Int ' how many balls to control
```

```
Dim mouseX,mouseY,cueAngle,cuePower As Float
```

```
Dim ballsmoving As Boolean' flag to indicate whether or not any of the balls  
are moving
```

```
Type balltype (x As Float, y As Float, dx As Float, dy As Float, color As Int)
```

```
Dim ball(50) As balltype
```

```
Dim n As Int
```

```
Dim tp As String
```

```
Dim tq As String
```

```
Dim mytext As String
```

```
End Sub
```

Sub Globals

```
'These global variables will be redeclared each time the activity is created.
```

```
'These variables can only be accessed from this module.
```

```
Dim centerX,centerY As Int ' center of the snooker table display area (panel  
2)
```

```
Dim powerBarX,powerBarY,powerBarWidth,powerBarHeight As Int ' power  
bar positions (panel 1)
```

```
Dim count As Int
```

```
' display-related variables
```

```
Dim pan1,pan2 As Panel
```

```
Dim can1,can2 As Canvas
```

```
Dim rec As Rect
```

```
End Sub
```

Sub Activity_Create(FirstTime As Boolean)

```
'Do not forget to load the layout file created with the visual designer. For  
example:
```

```

'Activity.LoadLayout("Layout1")
Activity.Title = "Snooker Gamified Learning"
' display / system setup
pan1.Initialize("panel1")    ' this panel will display the 'power bar' and 'take
shot' ball
pan2.Initialize("panel2")    ' this panel is the main snooker table area
Activity.AddView(pan1,0% x,0% y,12% x,100% y)
Activity.AddView(pan2,14% x,0% y,100% x-14% x,100% y)
can1.Initialize(pan1) : can2.Initialize(pan2)
centerX=pan2.Width/2 : centerY=pan2.Height/2
' How many pottable balls in game (excluding cue ball)
' NOTE: Use 3,6,10,15,21 ... (since the balls are placed in a triangle format)

NUMBALLS= 8 '15 how many ball will you like to play from 1 to 15?
' General physics settings
FRICTION=0.981 : BALL_MASS=60.0 :
BALL_RADIUS=pan2.Width/(NUMBALLS*1.5)
BALL_DIAMETER=BALL_RADIUS*2.0
' Timer
time.Initialize("Timer1",12)
' Menus
Activity.AddMenuItem("Reset", "Menu_ResetTable")
Activity.AddMenuItem("EditNumberofBall", "Menu_EditNumberofBall")
Activity.AddMenuItem("Exit", "Menu_ExitGame")
' power bar position
powerBarX=10 : powerBarY=pan1.Height-128 :
powerBarWidth=pan1.Width-20 : powerBarHeight=pan1.Height/2.5
'
If FirstTime=True Then Menu_ResetTable_Click
End Sub

Sub Activity_Resume
time.Enabled=True
awake.KeepAlive(True)
End Sub

Sub Activity_Pause (UserClosed As Boolean)
time.Enabled=False
awake.ReleaseKeepAlive
End Sub

' user has touched Panel 1 (the left panel)
Sub panel1_Touch (Action As Int, X As Float, Y As Float)
If ballsmoving=True Then Return
' check if touched point is over the 'power bar' indicator
If Y>=powerBarY-powerBarHeight And Y<=powerBarY Then
If Y<powerBarY-powerBarHeight+8 Then Y=powerBarY-
powerBarHeight+8
If Y>powerBarY-16 Then Y=powerBarY-16

```

```

        cuePower=(powerBarY-Y)/8.0
        RenderPanel1
        Return
    End If
    ' check if touch point is over the 'take shot' ball
    If Y>=powerBarY+32 Then
        cueAngle=180.0-ATan2D(mouseX-ball(0).X,mouseY-ball(0).y)
        ball(0).dx=SinD(cueAngle)*cuePower : ball(0).dy=-
        CosD(cueAngle)*cuePower
        can1.DrawColor(Colors.Black) : pan1.Invalidate
        ballsmoving=True

    End If

    If File.Exists(File.DirAssets, n & tp) Then
        Dim mediap As MediaPlayer
        Dim timer2 As Timer
        mediap.Initialize()
        mediap.Load(File.DirAssets, "3.wav")
        timer2.Initialize("timer2", 1000)
        mediap.play
        Sleep(1500)
        StartActivity(dialog2)

    Else
        'restartlevel
        ToastMessageShow("Sorry you missed it! No reward for lazy student,
        Try shooting again",True)
        'MsgboxAsync("Sorry you wasted effort fighting enemies trying to
        invade the Earth! No content, No reward for you, Try again!", "No Reward")
    End If
End Sub

Sub panel2_Touch (Action As Int, X As Float, Y As Float)
    mouseX=X : mouseY=Y : RenderPanel2

End Sub

Sub panel2_click
    Dim p As Panel = Sender
    ToastMessageShow(p.tag & "hit me n" & p.tag,False)
End Sub
' Reset the table
Sub Menu_ResetTable_Click()
    SetupTriangle : SetupCueBall : ballsmoving=True
    RenderPanel1 : RenderPanel2
End Sub

Sub Menu_ExitGame_Click()

```

```

        Activity.Finish
    End Sub

```

```

Sub Menu_EditNumberOfBall_Click()

```

```

    Dim Id As InputDialog
    Dim Bmp As Bitmap
    Dim ret

```

```

    Bmp.Initialize(File.DirAssets, "android49b.png")
    Id.Input = ""

```

```

    Id.Hint = "Change number of Balls You Want to Play Here"
    Id.HintColor = Colors.ARGB(255, 0, 0, 0)

```

```

    ret = DialogResponse.NEGATIVE

```

```

    ret = Id.Show("Enter How Many Balls to Play Here", "Number of Balls",
"OK", "", "EXIT", Bmp)

```

```

    If ret <> -1 Then

```

```

        MsgBoxAsync("Your Entry is canceled!", "Entry Canceled")

```

```

    Else

```

```

        NUMBALLS = Id.Input

```

```

    End If

```

```

End Sub

```

```

Sub Timer1_Tick

```

```

    count=count+1

```

```

    If ballsmoving=True Then

```

```

        UpdatePhysics

```

```

        RenderPanel2

```

```

        If count Mod(20)=0 Then

```

```

            If AreBallsMoving=False Then

```

```

                ballsmoving=False : RenderPanel1 : RenderPanel2

```

```

            End If

```

```

        End If

```

```

    End If

```

```

End Sub

```

```

Sub RenderPanel1()

```

```

    ' power bar indicator

```

```

    rec.Initialize(powerBarX,powerBarY-

```

```

powerBarHeight,powerBarX+powerBarWidth,powerBarY)

```

```

    can1.DrawRect(rec,Colors.Blue,True,0)

```

```

    rec.Initialize(powerBarX+5,powerBarY-

```

```

(cuePower*8),powerBarX+powerBarWidth-6,powerBarY-8)

```

```

    can1.DrawRect(rec,Colors.White,True,0)

```

```

    ' take shot ball

```

```

    can1.DrawCircle(powerBarX+(powerBarWidth/2.0),powerBarY+64,pan1.Wi
dth/2-20,Colors.LightGray,True,0)

```

```

        can1.DrawCircle(powerBarX+(powerBarWidth/2.0),powerBarY+64,pan1.Width/2-26,Colors.White,True,0)
        pan1.Invalidate
    End Sub

```

```

Sub RenderPanel2()

```

```

        can2.DrawColor(Colors.RGB(16,127,78)) ' erase the background with the
        given colour
        ' Draw each ball. Note that ball(0) is the cue ball
        For i=0 To NUMBALLS
            can2.DrawCircle(ball(i).x, ball(i).y, BALL_RADIUS, ball(i).color,
            True,0)
        Next
        ' Render the aiming line and circle (only when all balls have stopped moving)
        If ballsmoving=False Then
            can2.DrawLine(ball(0).x,ball(0).y,mouseX,mouseY,Colors.Black,4.0)

            can2.DrawCircle(mouseX,mouseY,BALL_RADIUS,Colors.Black,False,6.0)
        End If
        pan2.Invalidate
    End Sub

```

```

' Arrange balls in a triangle formation

```

```

Sub SetupTriangle()

```

```

    Dim ballTriangleSize,i As Int
    i=0
    Do Until i>=NUMBALLS
        ballTriangleSize=ballTriangleSize+1
        i=i+ballTriangleSize
    Loop
    i=1
    For xloop=ballTriangleSize To 1 Step -1
        For yloop=1 To xloop
            ball(i).y=(5-xloop)*BALL_DIAMETER+120+RNum
            ball(i).x=(yloop*BALL_DIAMETER)-
            (xloop*BALL_DIAMETER)/2.0+(centerX)+RNum
            ball(i).dx=0.0 : ball(i).dy=0.0
            ' yellow or red ball colour
            If i Mod(2)=0 Then
                ball(i).color=Colors.RGB(210,30,20)
            Else
                ball(i).color=Colors.RGB(240,200,18)
            End If
            i=i+1
        Next
    Next
End Sub

```

```

' Position the cue ball and set the aiming direction to point above the ball

```

Sub SetupCueBall()

```
ball(0).x=centerX+BALL_RADIUS+RNum
ball(0).y=pan2.Height-BALL_RADIUS-Rnd(60,65)
ball(0).dx=0.0 : ball(0).dy=0
ball(0).color=Colors.White
mouseX=centerX+BALL_RADIUS+Rnd(-10,10) :
mouseY=pan2.Height/2.75 : cuePower=Rnd(70,80)
End Sub
```

Sub UpdatePhysics()

```
Dim actualDist, collisionNormalAngle, moveDist As Float
Dim nX, nY, a1, a2, optimisedP As Float
For i=0 To NUMBALLS
    ' MOVEMENT
    ' Update ball position
    ball(i).x=ball(i).x+ball(i).dx : ball(i).y=ball(i).y+ball(i).dy
    ' Slow the ball down via the global friction value
    ball(i).dx=ball(i).dx*FRICTION : ball(i).dy=ball(i).dy*FRICTION
    ' Stop ball completely when below certain speed
    If Abs(ball(i).dx)<0.068 Then ball(i).dx=0.0
    If Abs(ball(i).dy)<0.068 Then ball(i).dy=0.0
    ' COLLISION CHECKS
    ' Check each other ball (b) against current ball (i)
    For b=0 To NUMBALLS
        ' No need to check ball against itself
        If b=i Then Continue
        ' Get the distance between the 2 balls being checked
        actualDist=Sqrt( Power(ball(b).x-ball(i).x,2) +
        Power(ball(b).y-ball(i).y,2) )
        ' Collided? Check actual distance against ball diameter
        If actualDist<BALL_DIAMETER Then
            ' Obtain the angle of ball (b) against ball (i)
            collisionNormalAngle=ATan2D(ball(b).y-
            ball(i).y,ball(b).x-ball(i).x)
            ' Position exact touch (no intersection)
            moveDist=(BALL_DIAMETER-actualDist)*0.5

            ball(i).x=ball(i).x+moveDist*CosD(collisionNormalAngle+180)
            ball(i).y=ball(i).y+moveDist*SinD(collisionNormalAngle+180)

            ball(b).x=ball(b).x+moveDist*CosD(collisionNormalAngle)
            ball(b).y=ball(b).y+moveDist*SinD(collisionNormalAngle)
        ' COLLISION RESPONSE
        ' n = vector connecting centres of balls
        ' Find components normalised vector
        nX=CosD(collisionNormalAngle)
        nY=SinD(collisionNormalAngle)
```

```

product)
' Find length of components movement vectors (via dot
product)
a1=ball(i).dx*nX + ball(i).dy*nY
a2=ball(b).dx*nX + ball(b).dy*nY
' Optimised = 2*(a1-a2)/(BallMass1+BallMass2)
optimisedP=(2.0 * (a1-a2) ) / (BALL_MASS*2)
' Find resultant vectors
ball(i).dx=ball(i).dx-(optimisedP*BALL_MASS*nX)
ball(i).dy=ball(i).dy-(optimisedP*BALL_MASS*nY)
ball(b).dx=ball(b).dx+(optimisedP*BALL_MASS*nX)
ball(b).dy=ball(b).dy+(optimisedP*BALL_MASS*nY)
End If
Next
' Simple bounce off walls check
If ball(i).x<BALL_RADIUS Then
ball(i).x=BALL_RADIUS : ball(i).dx=ball(i).dx*-0.9
End If
If ball(i).x>pan2.Width-BALL_RADIUS Then
ball(i).x=pan2.Width-BALL_RADIUS : ball(i).dx=ball(i).dx*-
0.9
End If
If ball(i).y<BALL_RADIUS Then
ball(i).y=BALL_RADIUS : ball(i).dy=ball(i).dy*-0.9
End If
If ball(i).y>pan2.Height-BALL_RADIUS Then
ball(i).y=pan2.Height-BALL_RADIUS :
ball(i).dy=ball(i).dy*-0.9
End If
Next
End Sub

' Return TRUE if any of the balls are moving
Sub AreBallsMoving() As Boolean
For obj=0 To NUMBALLS
If ball(obj).dx<>0.0 Or ball(obj).dy<>0.0 Then Return True
Next
Return False
End Sub

' Return a random float between -0.5 and +0.5
' Used to add a slight re-positioning of the balls
Sub RNum() As Float
Dim f As Float = Rnd(-100,100)
Return f/200.0
End Sub

#Region EVENTS
#Event: Click (Index As Int, Text As String)

```

#End Region

#Region Designer properties

#DesignerProperty: Key: FillColor, DisplayName: Fill Color, FieldType: Color, DefaultValue: 0xFFFFFFFF

#DesignerProperty: Key: MenuItemType, DisplayName: MenuItemType, FieldType: String, DefaultValue: Both, List: Both|Image|Text

#DesignerProperty: Key: StrokeColor1, DisplayName: Stroke color, Description: Stroke gradient first color, FieldType: Color, DefaultValue: 0xFF0000FF

#DesignerProperty: Key: StrokeColor2, DisplayName: Stroke color, Description: Stroke gradient second color, FieldType: Color, DefaultValue: 0xFFCCCCFF

#DesignerProperty: Key: StrokeGradientOrientation, DisplayName: Orientation, Description: Stroke gradient orientation, FieldType: String, DefaultValue: TL_BR,

List:

TL_BR|TOP_BOTTOM|TR_BL|LEFT_RIGHT|RIGHT_LEFT|BL_TR|BOTTOM_TOP|BR_TL|RECTANGLE

#End Region

Sub Class_Globals

Private mEventName As String 'ignore

Private mCallback As Object 'ignore

Private mBase As B4XView 'ignore

Private xui As XUI 'ignore

Private bc As BitmapCreator

Private iv As B4XView

Public Items As List

Private Centers As List

Public lstLabels As List

Public lstImageViews As List

Private pnl As B4XView

Private UpdatedCenters As List

Public FillColor As Int

Public PressedFilledColor As Int = xui.Color_Black

Public PressedTextColor As Int = xui.Color_White

Private TextColor As Int

Private PressedIndex As Int

Public Const MENU_ITEM_TYPE_BOTH As String = "Both"

Public Const MENU_ITEM_TYPE_IMAGE As String = "Image"

Public Const MENU_ITEM_TYPE_TEXT As String = "Text"

Private mMenuItemType As String

Private GradientBrush As BCBrush

Private StrokeColor1, StrokeColor2 As Int

Private StrokeGradientOrientation As String

End Sub

Public Sub **Initialize** (Callback As Object, EventName As String)

mEventName = EventName

mCallback = Callback

```

Items.Initialize
Dim s As Float = CosD(30)
Centers.Initialize
Centers.Add(Array As Float(0, 0))
Centers.Add(Array As Float(-1.5, -s))
Centers.Add(Array As Float(0, -2 * s))
Centers.Add(Array As Float(1.5, -1 * s))
Centers.Add(Array As Float(1.5, 1 * s))
Centers.Add(Array As Float(0, 2 * s))
Centers.Add(Array As Float(-1.5, 1 * s))
lstLabels.Initialize
lstImageViews.Initialize
UpdatedCenters.Initialize
End Sub

```

'Base type must be Object

```

Public Sub DesignerCreateView (Base As Object, Lbl As Label, Props As Map)
    mBase = Base
    mMenuItemType = Props.Get("MenuItemType")
    FillColor = xui.PaintOrColorToColor(Props.Get("FillColor"))
    StrokeColor1 = xui.PaintOrColorToColor(Props.Get("StrokeColor1"))
    StrokeColor2 = xui.PaintOrColorToColor(Props.Get("StrokeColor2"))
    StrokeGradientOrientation = Props.Get("StrokeGradientOrientation")
    Dim iv1 As ImageView
    iv1.Initialize("")
    iv = iv1
    mBase.AddView(iv, 0, 0, 0, 0)
    mBase.SetColorAndBorder(xui.Color_Transparent, 0, 0, 0)
    Dim origLabel As B4XView = Lbl
    TextColor = origLabel.TextColor
    For i = 0 To Centers.Size - 1
        If mMenuItemType = MENU_ITEM_TYPE_IMAGE Or
mMenuItemType = MENU_ITEM_TYPE_BOTH Then
            Dim NewImageView As ImageView
            NewImageView.Initialize("")
            Dim xImv As B4XView
            xImv = NewImageView
            mBase.AddView(xImv, 0, 0, 0, 0)
            lstImageViews.Add(xImv)
        End If

        If mMenuItemType = MENU_ITEM_TYPE_TEXT Or
mMenuItemType = MENU_ITEM_TYPE_BOTH Then
            Dim NewLabel As Label
            NewLabel.Initialize("")
            Dim xlbl As B4XView = NewLabel
            xlbl.TextSize = origLabel.TextSize
            xlbl.TextColor = TextColor
            xlbl.SetTextAlignment("CENTER", "CENTER")

```

```

        mBase.AddView(xlbl, 0, 0, 0, 0)
        lstLabels.Add(xlbl)
    End If
Next
pnl = xui.CreatePanel("pnl")
mBase.AddView(pnl, 0, 0, 0, 0)
If mBase.Width > 0 Then Base_Resize(mBase.Width, mBase.Height)
End Sub

#Region PROPERTIES
Public Sub setMenuItemType(ItemType As String)
    mMenuItemType = ItemType
End Sub
Public Sub getMenuItemType As String
    Return mMenuItemType
End Sub

#End Region

#Region PUBLIC METHODS

Public Sub Update
    bc.DrawRect(bc.TargetRect, xui.Color_Transparent, True, 0)
    Dim h As Int = Min(iv.Height, iv.Width)
    Dim r As Float = (h - 6dip) / 6
    UpdatedCenters.Clear
    For i = 0 To Centers.Size - 1
        Dim c() As Float = Centers.Get(i)
        Dim cx As Float = c(0) * r + h / 2
        Dim cy As Float = c(1) * r + h / 2
        If mMenuItemType = MENU_ITEM_TYPE_TEXT Or
mMenuItemType = MENU_ITEM_TYPE_BOTH Then
            Dim lbl As B4XView = lstLabels.Get(i)
            End If
        If mMenuItemType = MENU_ITEM_TYPE_IMAGE Or
mMenuItemType = MENU_ITEM_TYPE_BOTH Then
            Dim xImv As B4XView = lstImageViews.Get(i)
            End If
        If i <= Items.Size - 1 Then
            If mMenuItemType = MENU_ITEM_TYPE_TEXT Or
mMenuItemType = MENU_ITEM_TYPE_BOTH Then
                lbl.Text = Items.Get(i)
                lbl.SetLayoutAnimated(0, iv.Left + (cx - r), iv.Top +
(cy - r), (r * 2), (r * 2))
            End If
            If mMenuItemType = MENU_ITEM_TYPE_IMAGE Or
mMenuItemType = MENU_ITEM_TYPE_BOTH Then
                xImv.SetLayoutAnimated(0, iv.Left + (cx - r * .7),
iv.Top + (cy - r * .7), (r * 1.4), (r * 1.4))
            End If
        End If
    Next
End Sub

```

```

        End If
        UpdatedCenters.Add(Array As Float(cx, cy))
        DrawCell(cx + 0.5, cy + 0.5, r + 0.5, FillColor, 4dip)
    Else
        If mMenuItemType = MENU_ITEM_TYPE_TEXT Or
mMenuItemType = MENU_ITEM_TYPE_BOTH Then
            lbl.Text = ""
        End If
    End If
Next
bc.SetBitmapToImageView(bc.Bitmap, iv)
End Sub

#End Region

#Region PRIVATE METHODS

Private Sub DrawCell (CenterX As Int, CenterY As Int, Radius As Int, vFillColor
As Int, Thickness As Int)
    Dim s As Float = Radius * CosD(30)
    Dim p As BCPath
    p.Initialize(CenterX - Radius / 2, CenterY - s)
    p.LineTo(CenterX + Radius / 2, CenterY - s)
    p.LineTo(CenterX + Radius, CenterY)
    p.LineTo(CenterX + Radius / 2, CenterY + s)
    p.LineTo(CenterX - Radius / 2, CenterY + s).LineTo(CenterX - Radius,
CenterY)
    bc.DrawPath(p, vFillColor, True, 0)
    bc.DrawPath2(p, GradientBrush, False, Thickness)
End Sub

#End Region

#Region EVENTS

Private Sub Base_Resize (Width As Double, Height As Double)
    Dim mn As Double = Min(Width, Height)
    iv.SetLayoutAnimated(0, Width / 2 - mn / 2, Height / 2 - mn / 2, mn, mn)
    pnl.SetLayoutAnimated(0, iv.Left, iv.Top, iv.Width, iv.Height)
    bc.Initialize(iv.Width, iv.Height)
    bc.FillGradient(Array As Int(StrokeColor1, StrokeColor2), bc.TargetRect,
StrokeGradientOrientation)
    GradientBrush = bc.CreateBrushFromBitmap(bc.Bitmap)
    Update
End Sub

Private Sub Pnl_Touch (Action As Int, X As Float, Y As Float)
    If Action = pnl.TOUCH_ACTION_DOWN Then
        Dim h As Int = Min(iv.Height, iv.Width)

```

```

Dim r As Float = (h - 6dip) / 6
Dim MinR As Float = r * 1000
Dim MinI As Int
For i = 0 To UpdatedCenters.Size - 1
    Dim cc() As Float = UpdatedCenters.Get(i)
    Dim dist As Float = Sqrt(Power(cc(0) - x, 2) + Power(cc(1) -
y, 2))

    If dist < MinR Then
        MinR = dist
        MinI = i
    End If
Next
If MinR < r Then
    Dim cc() As Float = UpdatedCenters.Get(MinI)
    DrawCell(cc(0) + 0.5, cc(1) + 0.5, r + 0.5, PressedFilledColor,
3dip)

    If mMenuItemType = MENU_ITEM_TYPE_TEXT Or
mMenuItemType = MENU_ITEM_TYPE_BOTH Then
        Dim lbl As B4XView = lstLabels.Get(MinI)
        lbl.TextColor = PressedTextColor
    End If
    bc.SetBitmapToImageView(bc.Bitmap, iv)
    CallSub3(mCallBack, mEventName & "_Click", MinI,
Items.Get(MinI))
    PressedIndex = PressedIndex + 1
    Dim MyIndex As Int = PressedIndex
    Sleep(100)
    If mMenuItemType = MENU_ITEM_TYPE_TEXT Or
mMenuItemType = MENU_ITEM_TYPE_BOTH Then
        lbl.TextColor = TextColor
    End If
    If MyIndex <> PressedIndex Then Return
Update
End If
End If
End Sub
#End Region

```