Ain Shams University

Faculty of Engineering

Computer and Systems Engineering Department

THE ENGINEERING EDUCATIONAL GAME OF ABDO PASHA PALACE

By

Ahmed Gomaa Abdel Aal (43705)

Ismael Khaled Youssef (43736)

Gasser Samy Abdelhady (43766)

Maged Mahmoud Mabrouk (43844)

Mohammed Abd Elhady Abd Elazim (43870)

Menna Allah Muhammed Abdelrahman (43898)

Supervised by

Dr. Islam Ahmed El-Maddah

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Ain Shams University, Cairo, Egypt

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ABSTRACT

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The main goal of our project was to introduce the possibility of learning through games, focusing specifically on some of the courses taught in engineering education.

Classroom education is the most dominant approach to teaching in most countries, and while it provides various benefits that cannot be replaced by other approaches, classroom education alone is not enough. Learning outside the classroom is as essential as learning inside it, as Education is not only about acquiring knowledge but also about understanding the situations to which this knowledge applies among many other things. Outside Education not only provides the chance to understand difficult concepts more quickly but also gives a deeper understanding of fundamental concepts.[1]

Traditional Education focuses more on standardized curriculum and passing tests as opposed to student-focused learning; it lacks interactivity and focuses more on the theoretical which may provide little context and lead to the learners to disconnect later on.[2] Technology brings changes to education such as more flexibility, more focus on the learning process then on grades and more variety than that limited by your location.[3]

Games in Education is an approach that provides interactivity, flexibility and the challenge to prevent boredom or losing the motivation to complete learning difficult concepts. This thesis improves the engineering education through adding interactivity and gaming.

[1] http://www.powerfulschools.org/is-education-beyond-classroom-important-for-students/
[2] https://classroom.synonym.com/disadvantages-traditional-classroom-training-7866705.html
[3] http://www.powerfulschools.org/role-of-technology-in-the-teaching-methods/

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Chapter 1 INTRODUCTION

1.1 Classical education

Education is the process of facilitating learning, or the acquisition of knowledge, skills, values, beliefs, and habits. Educational methods include storytelling, discussion, teaching, training, and directed research. Education frequently takes place under the guidance of educators, however learners may also educate themselves. Education can take place in formal or informal settings and any experience that has a formative effect on the way one thinks, feels, or acts may be considered educational. The methodology of teaching is called pedagogy.

Formal education is commonly divided formally into such stages as preschool or kindergarten, primary school, secondary school and then college, university, or apprenticeship.

Education began in prehistory, as adults trained the young in the knowledge and skills deemed necessary in their society. In pre-literate societies, this was achieved orally and through imitation. Story-telling passed knowledge, values, and skills from one generation to the next. As cultures began to extend their knowledge beyond skills that could be readily learned through imitation, formal education developed. Schools existed in Egypt at the time of the Middle Kingdom.

Before technological interference, for many years education seems quite the same throughout the centuries. A 14th century illustration by Laurentius de Voltolina depicts a university lecture in medieval Italy. The scene is easily recognizable because of its parallels to the modern day. The teacher lectures from a podium at the front of the room while the students sit in rows and listen. Some of the students have books open in front of them and appear to be following along. A few look bored. Some are talking to their neighbors. One appears to be sleeping. Ten years ago classrooms did not look much different. The use of boards and books was the core of learning process for hundreds of years.

1.2 Education using technology

Educational technology is the use of both physical hardware, software, and educational theoretic to facilitate learning and improving performance by creating, using, and managing appropriate technological processes and resources

It encompasses several domains including learning theory, computer-based training, online learning, and where mobile technologies are used, m-learning. Accordingly, there are several discrete aspects to describing the intellectual and technical development of educational technology:

- Educational technology as the theory and practice of educational approaches to learning.
- Educational technology as technological tools and media, for instance massive online courses, that assist in the communication of knowledge, and its development and exchange. This is usually what people are referring to when they use the term "EdTech".
- Educational technology for learning management systems (LMS), such as tools for student and curriculum management, and education management information systems (EMIS).
- Educational technology as back-office management, such as training management systems for logistics and budget management, and Learning Record Store (LRS) for learning data storage and analysis.
- Educational technology itself as an educational subject; such courses may be called "Computer Studies" or "Information and communications technology (ICT)".

1.2.1 History

Helping people and children learn in ways that are easier, faster, more accurate, or less expensive can be traced back to the emergence of very early tools, such as paintings on cave walls. Various types of abacus have been used. Writing slates and blackboards have been used for at least a millennium. From their introduction, books and pamphlets have held a prominent role in education. From the early twentieth century, duplicating machines such as the mimeograph and Gestetner stencil devices were used to produce short copy runs (typically 10–50 copies) for classroom or home use. The use of media for instructional purposes is generally traced back to the first

decade of the 20th century with the introduction of educational films (1900s) and Sidney Pressey's mechanical teaching machines (1920s). The first all multiple choice, large-scale assessment was the Army Alpha, used to assess the intelligence and more specifically the aptitudes of World War I military recruits. Further large-scale use of technologies was employed in training soldiers during and after WWII using films and other mediated materials, such as overhead projectors. The concept of hypertext is traced to the description of memex by Vannevar Bush in 1945.

Slide projectors were widely used during the 1950s in educational institutional settings. Cuisenaire rods were devised in the 1920s and saw widespread use from the late 1950s.

In the mid-1960s, Stanford University psychology professors, Patrick Suppes and Richard C. Atkinson, experimented with using computers to teach arithmetic and spelling via Teletypes to elementary school students in the Palo Alto Unified School District in California. Stanford's Education Program for Gifted Youth is descended from those early experiments.

Online education originated from the University of Illinois in 1960. Although internet would not be created for another nine years, students were able to access class information with linked computer terminals. The first online course was offered in 1986 by the Electronic University Network for DOS and Commodore 64 computers. Computer Assisted Learning eventually offered the first online courses with real interaction. In 2002, MIT began providing online classes free of charge. As of 2009, approximately 5.5 millions students were taking at least one class online. Currently, one out of three college students takes at least one online course while in college. At DeVry University, out of all students that are earning a bachelor's degree, 80% earn two-thirds of their requirements online. Also in 2014, 2.85 millions students out of 5.8 million students that took courses online, took all of their courses online. From this information, it can be concluded that the number of students taking classes online is on the steady increase.

In 1971, Ivan Illich published a hugely influential book called, Deschooling Society, in which he envisioned "learning webs" as a model for people to network the learning they needed. The 1970s and 1980s saw notable contributions in computer-based learning by Murray Turoff and Starr Roxanne Hiltz at the New Jersey Institute of Technology as well as developments at the University of Guelph in CanadaIn the UK, the Council for Educational Technology supported the use of educational technology, in particular administering the government's National Development Programme in Computer Aided Learning (1973–77) and the Microelectronics Education Programme (1980–86).

By the mid-1980s, accessing course content became possible at many college libraries. In computer-based training (CBT) or computer-based learning (CBL), the learning interaction was between the student and computer drills or micro-world simulations.

Digitized communication and networking in education started in the mid-1980s. Educational institutions began to take advantage of the new medium by offering distance learning courses using computer networking for information. Early e-learning systems, based on computer-based learning/training often replicated autocratic teaching styles whereby the role of the e-learning system was assumed to be for transferring knowledge, as opposed to systems developed later based on computer supported collaborative learning (CSCL), which encouraged the shared development of knowledge.

Videoconferencing was an important forerunner to the educational technologies known today. This work was especially popular with museum education. Even in recent years, videoconferencing has risen in popularity to reach over 20,000 students across the United States and Canada in 2008–2009. Disadvantages of this form of educational technology are readily apparent: image and sound quality is often grainy or pixelated; videoconferencing requires setting up a type of mini-television studio within the museum for broadcast, space becomes an issue; and specialised equipment is required for both the provider and the participant.

The Open University in Britain and the University of British Columbia (where Web CT, now incorporated into Blackboard Inc., was first developed) began a revolution of using the Internet to deliver learning, making heavy use of web-based training, online distance learning and online discussion between students. Practitioners such as Harasim (1995) put heavy emphasis on the use of learning networks.

With the advent of World Wide Web in the 1990s, teachers embarked on the method using emerging technologies to employ multi-object oriented sites, which are text-based online virtual reality systems, to create course websites along with simple sets of instructions for its students.

By 1994, the first online high school had been founded. In 1997, Graziadei described criteria for evaluating products and developing technology-based courses that include being portable, replicable, scalable, affordable, and having a high probability of long-term cost-effectiveness.

Improved Internet functionality enabled new schemes of communication with multimedia or webcams. The National Center for Education Statistics estimate the number of K-12 students enrolled in online distance learning programs increased by 65 percent from 2002 to 2005, with greater flexibility, ease of communication between teacher and student, and quick lecture and assignment feedback.

According to a 2008 study conducted by the U.S Department of Education, during the 2006–2007 academic year about 66% of postsecondary public and private schools participating in student financial aid programs offered some distance learning courses; records show 77% of enrollment in for-credit courses with an online component. In 2008, the Council of Europe passed a statement endorsing e-learning's potential to drive equality and education improvements across the EU.

Computer-mediated communication (CMC) is between learners and instructors, mediated by the computer. In contrast, CBT/CBL usually means individualized (self-study) learning, while CMC involves educator/tutor facilitation and requires scenarization of flexible learning activities. In addition, modern ICT provides education with tools for sustaining learning communities and associated knowledge management tasks.

Students growing up in this digital age have extensive exposure to a variety of media. Major high-tech companies have funded schools to provide them the ability to teach their students through technology.

2015 was the first year that private nonprofit organizations enrolled more online students than for-profits, although public universities still enrolled the highest number of online students. In the fall of 2015, more than 6 million students enrolled in at least one online course

1.2.2 Advantages

1. **Technology helps children to stay motivated during the learning process.**

   Most students don't like to go to school if they feel like they are wasting their time. When there is technology allowed in the classroom, then teachers have an opportunity to let kids work at a pace which suits them the best without disturbing others. They can look up additional information about a subject they are learning about that day, play educational games that reinforce the lesson.

   Because many of today's technology options allow students to see how well they are doing compared to the average of all users, it gives them a chance to push harder for themselves and their education. Many of the programs that encourage learning also issue rewards or award certificates, which helps to make the lessons fun as well.

2. **It encourages more communication between teachers and parents.**

   When there is technology in the classroom, then there are more opportunities for parents and teachers to connect with each other. Using a blog for the classroom can help parents get to see what their children are learning each day. Apps and software options allow teachers to instantly report on a child's behavior to let parents know in real-time what is happening

throughout the day. There are options for chat boxes, instant messaging, and other forms of communication as well.

It is important not to forget about email here either. Since the 1990s when this technology option came into the classroom, it created more reliability in messaging between teachers and parents should there be a need to talk.

3. **Technology options in the classroom are very affordable.**

Although the cost of having technology in the classroom can be significant if you are introducing new options to an entire district, the cost of student computers, tablets, and class essentials is minimal. Most student computers cost less than $200 each, and there are several grants available on local, state, and national levels that help to offset these costs to local taxpayers.

4. **It creates new ways to learn for today's student.**

There are three critical forms of intelligence that we see in children today: emotional, creative, and instructional. The traditional classroom environment, which typically encourages lecture-based lessons, focuses more on the latter option. Standardized tests and similar ranking tools do the same. When kids have access to technology today, then those who excel outside of the standard learning setup can still achieve their full potential.

Technology allows children to embrace their curiosity in multiple ways. They can try new things without embarrassment because their tech access gives them a level of anonymity. This process allows kids to work, through trial-and error if they wish, to see if a different strategy helps them to learn more effectively.

5. **Technology allows us to give students access to data from a single location.**

Do you remember when a research project meant a visit to the library so that you could pull 4-5 books to read, have access to an encyclopedia, and even microfilm to view so that you had enough resources to finish your assignment? Technology allows a student to access every item they need for a project from a central resource. Instead of spending all of that time searching for something specific or waiting for your library to order it, you can run a few queries on Google and find what you need.

6. **It gives us better access to behavioral data on students.**

   The various apps, software choices, and technological platforms collect data on students that can show attendance patterns, learning issues in specific subjects, and how they react in particular situations. This information leads to the creation of a profile where teachers, schools, and parents can work together to identify places where additional learning may be necessary. Technology can even help a school district find their highly capable students to keep pushing them toward more challenging work so that they remain engaged with the learning environment.

7. **Technology helps to prepare students for their future world.**

   Even if there are warnings from medical providers about the amount of screen time that students receive in their classroom environment, the reality of the modern educational system is that we must have technology exposure now to prepare our children for the world they will face as adults. This sector will continue to evolve. If they are not prepared to use these items today, then tomorrow could be a struggle for them.

   That means some traditional subjects might not be as important to teach for some schools or teachers. Is it more important to have a student learn how to write in cursive or know how to type without using the two-finger chicken-pecking method? Is coding more of a critical skill than learning how to cook? Should kids know how to put a chair together in woodshop or have the ability to put together their own computer?

   These are the questions we need to be asking when looking at the advantages and disadvantages of technology in the classroom.

8. **The introduction of technology allows for the teaching of needed vocational skills.**

   Although there are regions of extreme poverty and isolation which do not have Internet access over the world right now. By introducing technology to students from an early age, we can teach them the critical vocational skills

that are necessary for success in a digital world. That is why writing continues to be a top priority in the K-4 grades, formatting guidelines and software use after, and knowing how to research efficiently is approached as an essential skill.

9. **Technology in the classroom encourages collaboration.**

Students retain very little of the information they receive when a teacher lectures from a textbook. When there are interactive lessons on a chalkboard or whiteboard, kids can remember about 20% of what they were taught. If a teacher encourages a small group discussion, that percentage can quadruple.

Technology gives us an easy way to develop collaboration skills for students using online tools that encourage them to work together in safe ways. If kids can then practice what they were taught immediately, there is very little that they will forget.

10. **It encourages students to stay engaged with their learning environment.**

Kids get bored very easily when they feel like they already know what is being taught in their classroom. Some children will transform into mentors or leaders in this situation to help their fellow students, but there are many more who disengage because they lack stimulation. By introducing technology to the classroom, there are fewer places where repetitive learning must take place. Teachers can introduce new subjects, try new techniques, or use different projects to encourage ongoing learning, which creates more overall engagement.

11. **Teachers have more credibility when they use technology in the classroom.**

Teachers are sometimes hesitant to use technology in the classroom because they are unsure of what a student might have at home. Giving homework assignments that require computer access to a student without that technology at home would be a waste of time. There can also be pushback from parents who are uncomfortable giving their kids additional screen time for learning. When you can introduce these elements to the classroom and have children learn there, then you can overcome the socioeconomic barriers that are sometimes in place for low-income families.

1.2.3 Disadvantages

1. **The presence of technology can be distracting to students.**

   When kids play video games, they can find themselves reacting with addiction-like behaviors. Their focus is on the entertainment they receive more than anything else. If the educational environment uses reward-based games to encourage learning, then the child might be more concerned with what they receive through the software or app instead of what they are learning.

   Although correct answers can be an indication of knowledge, there might not be as much information retention as hoped. Teachers must set and enforce healthy boundaries when using technology in the classroom to ensure healthy results are possible.

2. **Technology can make it easier to cheat.**

   Remember the TV shows and movies where kids would break into a teacher's classroom, steal the answer key to a test, and then write down everything on their wrist, shoe, or a slip of paper? Now a student can send themselves a text with that information. They can send that data to anyone else with a phone. Email can relay this info too. There must also be strict rules in place about the use of technology during quizzes or tests when an exact measurement of student knowledge is needed to evaluate their overall progress.

3. **Using tech can cause some students to disconnect from the classroom.**

   Interacting online with others is a different experience than when you collaborate over the Internet with someone. Being behind a screen provides you with a layer of anonymity that you don't receive with a face-to-face conversation. Learning how to work with one another using technology is an essential skill, but it cannot be the other option that teachers introduce to their classroom. We must encourage social interactions that accurately communicate thoughts, feelings, or emotions so that when a child is offline, they can still make a better life for themselves

.

4. **Some students may not know the difference between reliable and unreliable resources.**

There is a lot of information on the Internet today that is fake or exaggerated in some way, but it masquerades as being real. According to research published by New York Magazine, less than 60% of web traffic today is actually human-based searches or content interaction. Up to half of the traffic on YouTube each year are bots that masquerade as people. Not only is the content sometimes fake, but then also the users might not be real too. Teachers must show students how to access real information, show them how to verify its validity, and then encourage them to use it appropriately.

5. **Technology is a resource that not all families can afford.**

Whether technology is in the classroom or at home, there is the issue of affordability to worry about in today's world. Some households cannot afford to purchase computers for their kids to manage their school work. There are school districts that don't have enough money to pay their salaries each year, much less add new tech components for learning.

When we emphasize having technology in the classroom, then we place those at the lowest end of the wage scale at a significant disadvantage. Students with greater access can learn more and have access to lessons more often, which means they have additional information exposure that can increase their opportunities to succeed.

6. **Some technologies could replace the teacher in some classrooms.**

Interactive learning lessons are so effective today that the software or app can become the teacher instead of having someone present to help a student. One of the best examples of this potential disadvantage is ABC Mouse, which provides clear instructions to students as young as 3 so that they can start learning when they are ready.

Instead of being in a hands-on role, technology makes the teacher more of an observer. New tech automates the learning process while adapting to changing student needs.

7. **There are privacy concerns to consider with technology in the classroom.**

Over 15 million people each year experience identity theft in some way. It is a criminal empire that costs the economy over $16 billion per year. Since 2011, over $100 billion in losses have happened because of this issue. One of the

reasons why it is becoming more prevalent is because more people have greater access to technology today.

When we introduce technology to the classroom, we are placing the identity of our children at risk every day. Even when apps, computers, mobile devices, and operating systems have advanced privacy filters that reduce the threat of identity loss, there is no way to guarantee that all risks are gone unless the equipment never goes online. If we take this step, then we end up losing many of the advantages of having technology in the classroom in the first place.

8. **Technology in the classroom could create medical problems for some kids.**

Eye strain occurs when you look at a computer screen for too long. Symptoms of this issue include back pain, eye pain, neck pain, feelings of tiredness, blurred vision, and problems with focus. Continuous heavy computer usage may lead to issues with early myopia, with a prevalence rate of more than 60% for those older than the age of 12. For some people, the impact of this health issue is cumulative, which means the time they spend in front of a phone, tablet, and television can contribute to eye health issues as well.

9. **Kids often lose track of time when using technology in the classroom.**

Although kids can adapt to changing environments without much of a second thought, their idea of normal is often defined by what they experience in the classroom. Teachers and schools have as much, if not more, time with children than their parents throughout the day, which means the classroom becomes an influential part of life for each student. Encouraging the use of tech might help to create more learning opportunities, but it can also lead to a lifestyle that is more sedentary.

When children sit for too long during the day, then they face the same health challenges that adults do when not getting enough exercise. There can be problems with obesity, hyperactivity, muscle fatigue, sleeping problems, and metabolism issues with prolonged sitting. That is why any school that introduces technology to the classroom should also encourage at least 30 minutes of moderate physical activity whenever possible.

10. **Many classrooms place limits on technology access.**

Because of the awareness that schools have with the potential disadvantages that technology can cause in the classroom, there are limits placed on the use of items under the guise of child protection. Although firewalls and site blockers can prevent most dangerous content from reaching the eyes of children, it is not unusual to see this issue taken a step further by restricting computer work to word processing and basic research. Students come home with assignments to use tech of their own, at a library, or through a loan program to place this responsibility on the parents instead.

If we force limits on children instead of teaching them how to make wise choices, then is that really giving them a learning environment?

11. **Technology can create dependencies for information recall.**

If you cannot recall a piece of information instantly, then what is your next step to find an answer? Most people would say that they would look online for the data they want or ask a virtual assistant, like Alexa, to give them the answer. Having access to a treasure-trove of resources is wonderful, but it can also create a dependency because of its presence. If we do not teach students how to recall info by themselves without the use of a smart device or computer, then the next generation of students may be unable to function unless there is technology for them to access.

1.3 Education using technology

The learning approach is a way more global and is gaining pace nowadays. Modern teaching aids are important and most preferred in the technological age. A modern education system uses technology to impart education. The growing usage of digital games and applied sciences into learning environments has affected both the teaching of educators and the learning of students. Game-Based Learning (GBL) can be successfully used to improve both learning and teaching. **It** simply means including games in your instruction. One of the greatest challenges for educator is with-success teaching giant groups of students, all of whom having totally different personalities, different capabilities and different learning preferences. With high expectations of everything digital, students wish variety of activities, rewards, surprises and humor to stay up their interest in learning. Finding new ways to grab the attention of learners and engaging them in the learning process is one of the main issues nowadays. Learning is not just rote memorization. Students won't be able to gain any information and skills out of dull learning process but they understand the application of skills and knowledge to solve real-life problems with help of effective learning process. The knowledge and skills acquired through game-based learning are retained longer than information from other learning methods. Effective learning process is one in which you are fully involved in what you are doing. In order to make learning effective, game-based learning requires games that are well designed and have well implemented learning tasks. A well-designed educational game could combine the learning objectives of the educational system with the fun, finished product of a commercial game and custom built games. Games designed specifically for the purpose of educating children can motivate self-learning and problem-solving skills to a great extent. Game-Based Learning simply means including knowledge matter of subject into games. All types of games are learning processes, be it casual gaming for fun, or something serious.

There are three approaches for embedding games and activities into the learning process. The first approach is based on learners designing and creating their own games according to their requirements; the second focuses on teachers, trainers or developers designing educational games from scratch according to learners' knowledge level; and the third one is to integrate commercial prefabricated games into the classroom activities for effective learning. Game-Based Learning plays important role in teaching by making students to collaborate, communicate, interact and work in teams. Strategic games improve the functioning of brain. Gaming creates a dynamic that can inspire learners to develop skills and build an emotional connection to learning and subject matter. Games can be customized to individualize teaching which assist students to become more confident and independent thinkers.

One of the key aspects of game-based learning is that each student receives immediate feedback on their performance, with suggestions on how they might improve. Care should be taken while using Game-based learning approach as it can be difficult to align learning objectives with educational model in game dynamics. It must meet the objectives and achieve proper alignment with curriculum.

Game-based learning has shifted focus from learning with lectures and written tasks to learning with games and it has become an indispensable part of modern education. To be a well-integrated member of contemporary society requires more than just the mastery of the basic skills of reading and writing. It allows learners to discover new methods of working towards achieving goals and objectives in an interactive manner. Let's hope that the latest trends of game-based learning will contribute for the betterment of students' learning and to the quality of knowledge and skills they gain.

Here is some important findings on games in education:

1- Games provide a 23% gain over traditional learning. 2013 research shows that games can increase learning outcomes by two grade levels.

2- Co-play is better. A study on motivation shows that when kids play together, outcomes are improved by 2 standard deviations.

3- Content should be married to game mechanics. A great 2011 study shows that games are powerful motivators, but they function better when the learning is the playful part and not just a side note. See more in my discussions about what makes a good game and intrinsic vs. extrinsic motivation for more information.

4- Games are more powerful combined with paratexts. A 2011 examination of simulation games shows that the text surrounding games aids, when combined with the game, in improving student outcomes more than the game alone.

5- Action games enhance attentional control. A 2012 study demonstrates that games are even effective at training us how to learn and shapes our attention.

6- Games are great for language gains. The research even showed that the language acquisition didn't even require that the game was a language game.

7- Reading gains are inherent to gaming, but choice is a key factor. If students were allowed choice in their in-game reading, the impact was

more powerful than the game alone according to Steinkuhler's own research.

8- Games are useful for overcoming bias and cognitive dissonance. The 2015 study demonstrates the power of games to overcome cognitive dissonance and reduce stereotypes.

9- Despite popular opinions, games promote learning and discourage negative behaviors. In fact, the study illustrates that regular game-play improved mental health as well as cognitive and social skills.

10- Games in research don't reflect games in the market. Sadly a forthcoming study shows that game makers and game researchers often have a disconnect in studying what is being created and creating what studies show is best. We can do better.

1.4 Game development

Video game development is the process of creating a video game. The effort is undertaken by a developer, ranging from a single person to an international team dispersed across the globe. Development of traditional commercial PC and console games is normally funded by a publisher, and can take several years to reach completion. Indie games usually take less time and money and can be produced by individuals and smaller developers. The independent game industry has been on the rise, facilitated by the growth of new online distribution systems such as Steam and Uplay, as well as the mobile game market for Android and iOS devices.

The first video games, developed in the 1960s, were noncommercial. They required mainframe computers to run and were not available to the general public. Commercial game development began in the '70s with the advent of first-generation video game consoles and early home computers like the Apple I. At that time, owing to low costs and low capabilities of computers, a lone programmer could develop a full and complete game. However, in the late '80s and '90s, ever-increasing computer processing power and heightened expectations from gamers made it difficult for a single person to produce a mainstream console or PC game. The average cost of producing a triple-A video game slowly rose, from US$1–4 million in 2000, to over $5 million in 2006, then to over $20 million by 2010.

Mainstream commercial PC and console games are generally developed in phases: first, in pre-production, pitches, prototypes, and game design documents are written; if the idea is approved and the developer receives funding, then full-scale development begins. The development of a complete game usually involves a team of 20–100 individuals with various responsibilities, including designers, artists, programmers, and testers.

Game development, production, or design is a process that starts from an idea or concept. Often the idea is based on a modification of an existing game concept. The game idea may fall within one or several genres. Designers often experiment with different combinations of genres. A game designer generally writes an initial game proposal document, that describes the basic concept, gameplay, feature list, setting and story, target audience, requirements and schedule, and finally staff and budget estimates. Different companies have different formal procedures and philosophies regarding game design and development. There is no standardized development method; however commonalities exist.

1.5 Thesis organization

Chapter 2 shows the meaning of visual education and how it can affect the learning process.

Chapter 3 focuses more on the educational games, the motivation behind it, the main keystones and how our game collected together.

Chapter 4 shows the development process and the detailed approach of how we planned our game.

Chapter 5 breaks down the whole game to its main parts.

Chapter 2 EDUCATION

2.1 Psychology:

2.1.1 Traditional Educational Method:

Traditional education is to transmit to a next generation those skills, facts, and standards of moral and social conduct that adults consider being necessary for the next generation's material and social success.

Traditional teacher-centered method focused on rote learning and memorization must be abandoned in favor of student-centered and task-based approaches to learning.

Probably the main argument levied against lecture-based classroom styles involves how little it truly engages students.

The average attention span is 10 minutes in university students; say some disconcerting studies, which isn't exactly conducive to most classes. Others posit the number might hover between 15 and 25.

We did a survey on some of the students of ***Faculty of Engineering – Ain Shams University.***

The following chart shows the responses of around 70 students from our faculty on how often they lose focus in lectures or tutorials, on the scale from one to five.

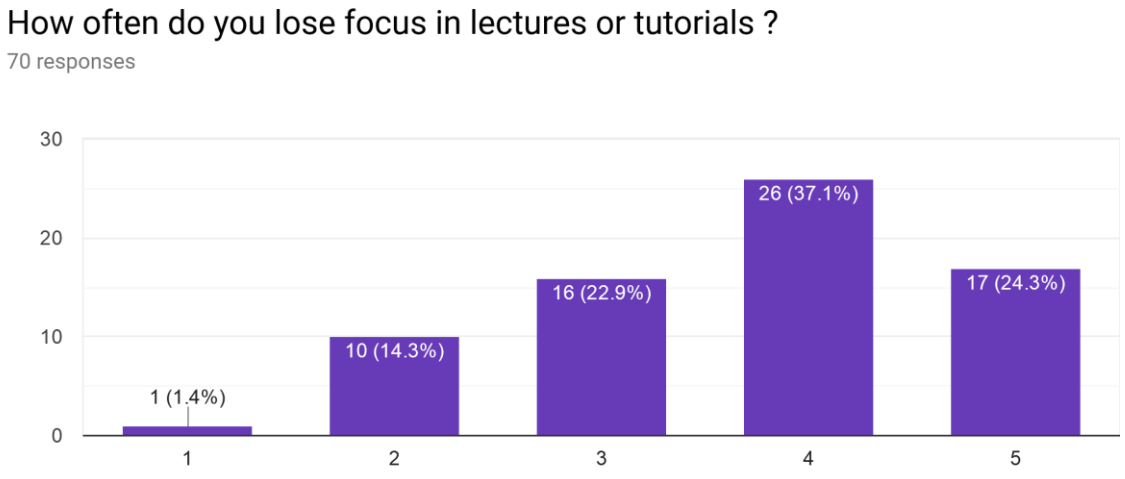

Figure 2.1 Chart showing how often do Students Lose Focus in Lectures or Tutorials

2.1.2 Alternative Education:

Alternative education is another educational method that encompasses many pedagogical approaches differing from mainstream pedagogy. Such alternative learning environments may be found within state, charter, and independent schools as well as home-based learning environments.

Many educational alternatives emphasize small class sizes, close relationships between students and teachers and a sense of community.

2.1.3 Gamification:

Gamification is the application of game-design elements and game principles in non-game contexts.

It can also be defined as a set of activities and processes to solve problems by using or applying the characteristics of game elements.

Gamification commonly employs game design elements to improve user engagement, organizational productivity, flow, learning, crowdsourcing, employee recruitment and evaluation, ease of use, usefulness of systems, physical exercise, traffic violations, voter apathy, and more.

A collection of research on gamification shows that a majority of studies on gamification find it has positive effects on individuals.

Gamification techniques are intended to leverage people's natural desires for socializing, learning, mastery, competition, achievement, status, self-expression, altruism, or closure, or simply their response to the framing of a situation as game or play.

Points are basic elements of a multitude of games and gamified applications. They are typically rewarded for the successful accomplishment of specified activities within the gamified environment and they serve to numerically represent a player's progress.

The arts, math, and sciences especially benefit from more interactive, hands-on approaches, which is why so many schools require studios and labs in addition to lectures, this is one of the points where Gamification can be helpful.

We can simply simulate scientific experiments with games at minimum cost, and steps can be repeated as many as needed, this method is also safer for some specific subjects such as: Chemistry, and Electrical Circuits.

Students prefer challenging methods provided in games than traditional methods, as shown in the chart below the responses of around 70 students from our faculty on How much they would prefer education through games over traditional educational techniques, on the scale from one to five.

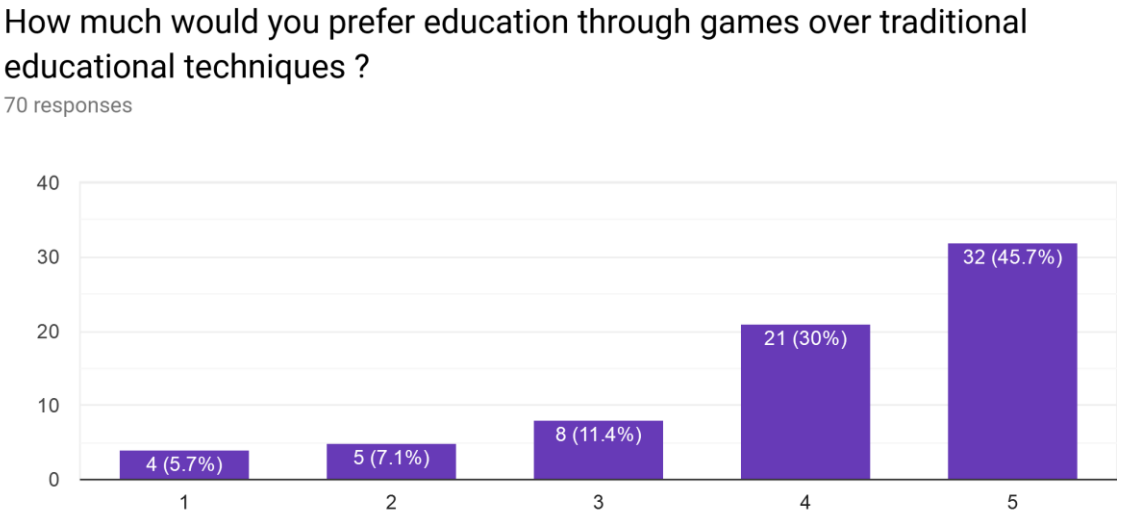

Figure 2.2 Chart showing how much would students prefer education through games

Also, the chart below shows the responses of around 70 students from our faculty on whether they would be interested to play a game with an educational purpose about an engineering subject or not, on the scale from one to five.

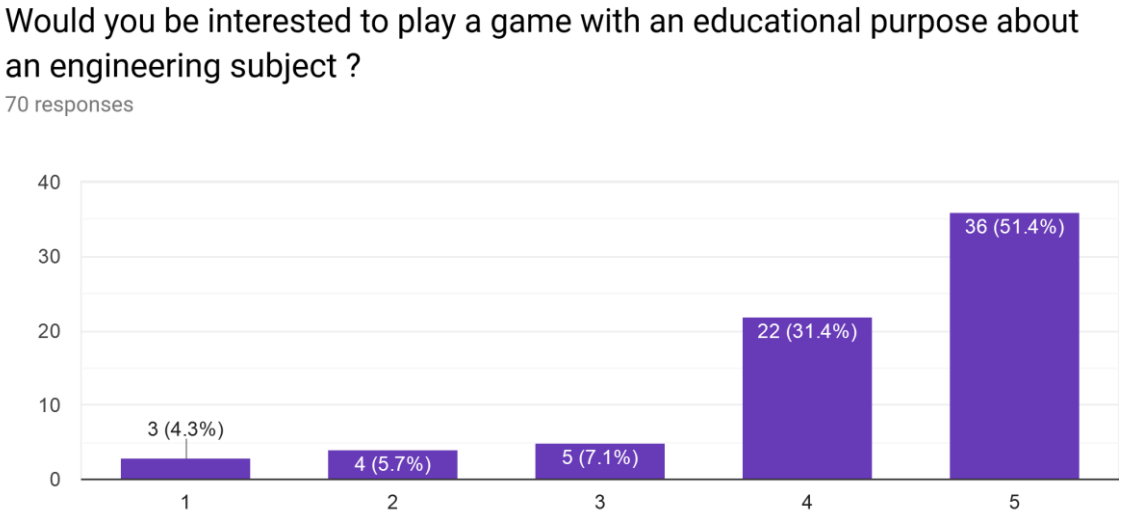

Figure 2.3 Chart showing how much interest in Engineering Education through Games

2.2 Educational Gaming:

Educational games are games explicitly designed with educational purposes, or which have incidental or secondary educational value.

All types of games may be used in an educational environment. also, Educational games are games that are designed to help people to learn about certain subjects, expand concepts, reinforce development, understand a historical event or culture, or assist them in learning a skill as they play.

An educational game is a game designed to teach humans about a specific subject and to teach them a skill. As educators, governments, and parents realize the psychological need and benefits of gaming have on learning, this educational tool has become mainstream.

Games teach us goals, rules, adaptation, problem solving, interaction, all represented as a story. They satisfy our fundamental need to learn by providing enjoyment, passionate involvement, structure, motivation, ego gratification, adrenaline, creativity, social interaction and emotion in the game itself while the learning takes place.

The Following Chart shows the responses of around 70 students from our faculty on How much they would like to see education through games implemented in the faculty's education process, on the scale from one to five.

Results show that over 50% of students are strongly interested in Game-based learning.

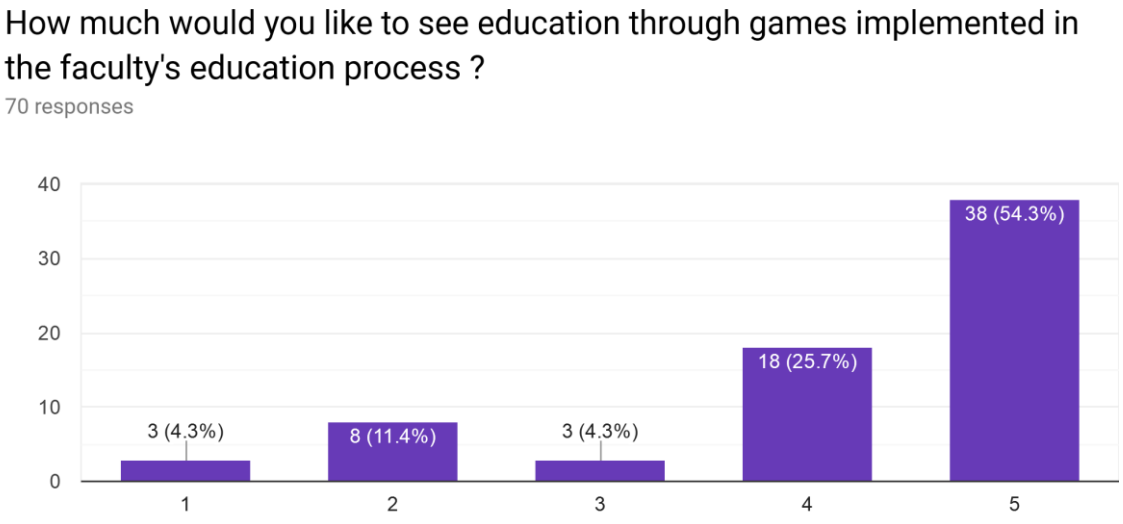

Figure 2.4 Chart showing how much Students would like to see education through games implemented in the faculty's education process

2.2.1 Game-based learning:

Game-based learning is a type of game play that has defined learning outcomes.

Generally, game-based learning is designed to balance subject matter with gameplay and the ability of the player to retain, and apply said subject matter to the real world.

It can be said that play and learning are synonymous, leading to cognitive and emotional development inside a social and cultural context.

2.2.2 Theory:

The success of game-based learning strategies owes to active participation and interaction being at the center of the experience, and signals that current educational methods are not engaging students enough.

The use of collaborative game-based role-play for learning provides an opportunity for learners to apply acquired knowledge and to experiment and get feedback in the form of consequences or rewards, thus getting the experiences in the "safe virtual world".

The built-in learning process of games is what makes a game enjoyable. The progress a player makes in a game is through learning. It is the process of the human mind grasping and coming to understand a new system.

The progress of understanding a new concept through gaming makes an individual feel a sense of reward.

2.2.3 Game Characters:

Identification with the character within the video game is an important factor in the learning potential of the gamer. Some of the electronic games allow the gamer to create an avatar that is designed and “owned” by the gamer. This character is an expression of the human creating the virtual character. This has opened a new set of scientific possibilities. The virtual world can be used as a laboratory. The relationships and space within the games can simulate complex societies and relationships without having to truly participate.

The fact that game creators and gamers are wanting new experiences within the games, and the introduction of “experiments” could increase the level of play and engagement.

As shown in the following image, we have created multiple characters in our game representing Teaching Assistants and other students, in order to simulate a real social experience.

These characters are supposed to interact with the player, and guide him using conversations.

Figure 2.5 In-Game Characters

2.3 Examples of Gamification in Education:

Gamification has been applied to almost every aspect of life. An example of Gamification in education can be seen in the American education system. Students are ranked in their class based on their earned grade-point average (GPA), which is comparable to earning a high score in video games. Students may also receive incentives, such as an honorable mention on the dean's list, the honor roll, and scholarships, which are equivalent to leveling-up a video game character or earning virtual currency or tools that augment game success.

Here are some examples of game designs, which capture the learners on a much deeper level. These games help the learners to master the skill or information, as they put them to competition or challenges. Meanwhile, they also offer rewards and both positive and negative feedback.

1. Medieval Swansea

This is a highly interactive game. It's a historical game in which learners take up the role of a detective to solve an old mystery. The game can be played on all digital devices.

The underpinning ideas of the game include various scenarios driven by different branches, character witnesses and narrative stages, including progression.

All of this helps learners to follow their progress and to know what is left to be done.

Every stage put learners to new challenges and provides them with instant feedback. The better they perform the better they can move on in the game.

2. Ribbon Hero

If we speak of corporate learning and gamification then Ribbon Hero is the game that first comes to mind.

The game helps in meeting the basic demands of **Microsoft Office**. It helps learners to learn **the basic tools of Microsoft Office**. As the learners play the game, they earn points for successfully completing the different challenges. The challenges are offered as text manipulation, page design, artistic presentation and a comprehensive section of quick points.

The game is smartly designed that put learners to various challenges while helping them developing Microsoft skills. Ribbon Hero tracks learners' progress and links, it with Facebook, allowing learners to share and compete with other learners.

3. Virtual Reality House:

At eLearning Awards, the game has been awarded gold medal twice. The skillful game let the trade trainees for instance plumbers to utilize and practice their learned skills in an immersive and real-life virtual reality simulation. The game helps them to polish their skills, improve competence and confidence and to learn from their mistakes.

The game comes with scenario-based learning, with different pathways for advanced learners and beginners. It offers the players with tools, fittings, and

fixtures the assist players in visualizing the real-life setting. Moreover, learners learn through step by step approach as they follow through the steps of planning, installation, and costing.

4. **DuoLingo:**

This game is actually a language-learning platform. The game offer combination of paid and free components i.e. free language learning and paid text translation feature.

The game offers different levels based on developed skills of the learners. It also comes with the features of websites and documents translation. In addition, the learners can look at other learners' translations, rate them and provide feedback. If the student completes the task within the time limit, they earn points as well as a time bonus. **Duolingo** is definitely a great achievement in terms of gamification in education.

5. **Brainscape**:

This is a simple learning-oriented game. This helps the learners to create exceptional flash cards to meet their learning capabilities. In such way they learn the ideas in the most comprehensive manner, leaving out the ones they already know. Since learners usually forget almost 90% of the material while studying, **brainscape** overcome this

issue with its smart flashcards. Teachers and students can create flashcards collaboratively, using the scientifically proven system of study.

6. **Knowre:**

In a traditional classroom, it is difficult for teachers to personalize the material. The high achievers may not be challenged enough or the low-graders might get frustrated due to lack of motivation. But as we speak of the potential of gamification in education, Knowre has enabled the instructors to personalize the course material in accordance with every learner's skill.

It is an adaptive math curriculum which enables instructors to provide personalized instructions to every student. It helps the student to get the experience and benefits of one-on-one learning. It helps students to break concept in a step-by-step process and help them in learning with more depth and with consistent feedback and review to overcome weak areas.

7. Lifesaver:

The game helps learners in understanding and applying the basic steps to save someone's life, suffering from choking or cardiac arrest.

The players are challenged on the basis of scenario-based approach, crisis simulation; choice of story and characters, and time limitations that help in understanding that time is essential in such circumstances. The learners can unlock levels as they progress and acquire the required skills and knowledge. Moreover, you can review your performance in the real-time, analyze your weak points and share your progress through various social media platforms to compete with other learners.

8. Virtonomics:

This is game that offers extensive strategic learning for higher education learners. However, there is no age limit to play this game. The game is played by over 1 million learners around the globe. The storyline of the game revolves around an economy which is full of businessmen, scientist, students, entrepreneurs, etc.

They live in a friendly yet business-oriented community. However, players have to use their strategic and analytical thinking, experience and knowledge to implement impactful business strategies in order to bring exponential success in your company.

Chapter 3 THE EDUCATIONAL GAME

3.1 Motivation:

The motivation for this project lies in the need for new means of education. We realize that while traditional lectures and tutorials are a great method of delivering information and applying on such information, the students however require more methods of visualizing and interacting with such information, and that lies in the idea of educational gaming.

Educational Gaming is the gamification of scientific content to deliver both the information we need to deliver, and some fun alongside it.

Our motivation however isn't just to spread educational gaming within our community, it is also to build a solid, robust foundation for the future colleagues to work on and improve, be that by adding their own new laboratories or by modifying the entire game. The game will be open source for any future generations to edit on and modify however, they see fit.

3.2 Software:

3.2.1 Unity Engine:

Figure 3.1 Unity Logo

First, we'll discuss the main component of our game development process, the 3D game engine we used to develop the entirety of the game.

While there are many game engines out there, we decided on Unity for its ease-of-navigation, and its lower learning curve.

Unity is a cross-platform game engine developed by Unity Technologies, first announced and released in June 2005 at Apple Inc.'s Worldwide Developers

Conference as a Mac OS X-exclusive game engine. As of 2018, the engine had been extended to support more than 25 platforms.

A game engine is the software that provides game creators with the necessary set of features to build games quickly and efficiently.

A game engine is a framework for game development that supports and brings together several core areas. You can import art and assets, 2D and 3D, from other software, such as Maya or 3s Max or Photoshop; assemble those assets into scenes and environments; add lighting, audio, special effects, physics and animation, interactivity, and gameplay logic; and edit, debug and optimize the content for your target platforms.

3.2.2 Visual Studio C#:

Figure 3.2 Microsoft Visual Studio Logo

Our editor of choice is the Microsoft Visual Studio, for the rich features it provides to developers with its IntelliSense and the add-on packages on demand.

Visual Studio includes a debugger that works both as a source-level debugger and as a machine-level debugger. It works with both managed code as well as native code and can be used for debugging applications written in any language supported by Visual Studio. In addition, it can also attach to running processes, monitor, and debug those processes. If source code for the running process is available, it displays the code as it is being run. If source code is not available, it can show the disassembly. The Visual Studio debugger can also create memory dumps as well as load them later for debugging. Multi-threaded programs are also supported.

The debugger can be configured to be launched when an application running outside the Visual Studio environment crashes.

Visual Studio also allows the integration with a version control platform such as GitHub to manage the work between the team and provide a clear, precise history of

the development of the project while also allowing a fail-safe recovery of an older version in case things go wrong.

A code snippet in Visual Studio C# looks as in Figure 3.3.

```
void Update()
    {
        if (disabled)
            return;
        if (draw)
        {
            gameObject.GetComponent<ConnectionControl>().CreateLine(firstClick,
secondClick);
            draw = false;
        }

        if (press && Input.GetMouseButton(1)) //Cancel first click
        {
            press = false;
            togColor = true;
            firstClick.GetComponent<SpriteRenderer>().color =
firstClick.GetComponent<LogicInteractable>().origColor;
            Debug.Log("First click has been cleared!");
        }

                                                                    }
```

Figure 3.3 Code Example from Movement Script

3.2.3 Mixamo & Mixamo Fuse:

Figure 3.4 Mixamo Website Logo

Figure 3.5 Mixamo fuse Logo

Our game requires unique 3D animated characters to traverse the "Palace of Abdo Pasha" which is part of the experience, for creating the 3D characters we used Adobe Fuse, and for animating them we used Mixamo.

Adobe Fuse CC is a 3D computer graphics software developed by Mixamo that enables users to create 3D characters. Its main novelty is the ability to import and integrate user-generated content into the character creator. This enabled us to create multiple 3D characters including the main protagonist of our game and multiple NPC characters tailored to our needs.

Fuse is a client-based product that lets users choose and modify character components such as body parts in real-time. Users can also customize their characters with clothing and texture options provided by Allegorithmic. Fuse's main novelty is the ability for users to import and automatically integrate their own content into the character creation system, leveraging all the features of pre-loaded content. Fuse characters are rigged through Mixamo online service. Characters have a bone driven rig and a blend shape based facial rig for facial animation.

As Fuse is a product of Mixamo, naturally, Mixamo provides an online service for animating the characters created through Fuse, and it allows "rigging" of the 3D characters.

The Auto Rigger applies machine learning to understand where the limbs of a 3D model are and to insert a "skeleton", or rig, into the 3D model as well as calculating the skinning weights. The service can take up to 2 minutes.

Mixamo's online services include an animation store featuring downloadable 3D models and animation sequences. The animations were created at Mixamo using motion capture and cleaned up by key frame animators. All its animations work with characters created in Fuse and/or rigged with Mixamo's Auto Rigger.

3.2.4 Blender/3DS Max:

Figure 3.6 Blender Logo

Figure 3.7 3DS Max logo

Our game required the creation of multiple models tailored to our exact specifications and needs, and for this, we needed a robust computer graphics software. For this, our programs of choice were Blender and Autodesk 3ds Max.

Blender is a free and open-source 3D computer graphics software toolset used for creating animated films, visual effects, art, 3D printed models, interactive 3D applications and video games. Blender's features include 3D modeling, UV unwrapping, texturing, raster graphics editing, rigging and skinning, fluid and smoke simulation, particle simulation, soft body simulation, sculpting, animating, match moving, rendering, motion graphics, video editing and compositing.

While Autodesk 3ds Max is a professional 3D computer graphics program for making 3D animations, models, games and images.

While both are very similar to each other, Blender however is free and open source while Autodesk 3ds Max isn't, meaning our work was mostly done on Blender because of the limitations of the trial version of Autodesk 3ds Max.

All in all, we used both of these programs to create a replica environment of the third floor of Abdo Pasha Palace with a replica of the laboratories found there for that to be the environment of our game, for an added sense of genuity and relatability to the game.

Students will almost feel like they are inside the Abdo Pasha Palace, which is a wanted bonus.

3.2.5 GitHub:

Figure 3.8 GitHub Logo

There are many version control solutions in today's market, our choice of version control solutions is GitHub.

It offers all of the distributed version control and source code management (SCM) functionality of Git as well as adding its own features. It provides access control and several collaboration features such as bug tracking, feature requests, task management, and wikis for every project.

Version control solutions provide the ability for teams to work together on projects with easy conflict mitigation and the ability to merge branches on demand and revert to older versions of the application.

Our project reached almost 100 commits on GitHub and we haven't faced any difficulties with using GitHub or resolving conflicts that occurred. While GitHub has a high learning slope, once it is mastered version control becomes as easy as ever.

3.2.6 GIMP:

Figure 3.9 GIMP Logo

GIMP (GNU Image Manipulation Program) is a free and open-source raster graphics editor used for image retouching and editing, free-form drawing, converting between different image formats, and more specialized tasks.

Our team utilized GIMP to design multiple sprites and backgrounds for the mini-games (laboratories) we added to our project.

One example of the backgrounds is the one designed for the Resistance Lab through GIMP:

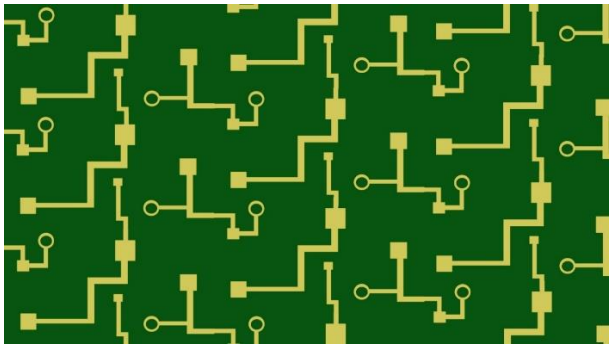

Figure 3.10 Sample of our work in GIMP

Chapter 4 DEVELOPMENT PROCESS

4.1 Design Phase:

Planning phase of the project is focused on idea and concept of our game as well at other criteria that will impact the game deeply, such as choosing the proper tools for the concept, determining the environment of the game, characters and camera movement all fall within the initial process before starting to developing the game itself.

The goal of concept development is to produce clear and easy to understand documentation, which describes all the tasks, schedules and estimates for the development team.

4.1.1 Game Design:

The game design is a collaborative process of designing the content and the rules of the game, reflecting our vision of the game and how it simulates reality.

Initially before taking any implementation steps we invested time in brainstorming many possible ideas to implement many levels that we could add to the game that will enrichen the user experience in this case the student.

So our choice of playable games came within the educational process we've already went through and related with, games related to the Computer Science field.

4.1.2 Environment:

The game environment is display that will hold within it all the game objects, components and features that will be displayed to the player.
And it was important for us to tailor to look just like our college.

Designing the game environment was the first stage that we had to tackle, as creating a custom environment required creating 3D object from scratch and giving it all the attributes that the real-life objects had,

Our environment consisted of:

1. The 2nd floor corridors of the main building in ASUFE. This includes all real-life specific details like IEEE area, doors, plants, announcement boards, stairs and ceiling lights

2. The computer laboratory rooms. Which includes all the computers, tables and chairs and tailored room design?

3. The Logic room and the drawing room

4. All non-playable characters (NPCs) that you can interact with or watching moving along the corridors.

5. Lighting (Point lights that cast shadows on all objects and give the game a realistic edge).

4.1.3 Level creation:

In general, almost all games consist of several levels that lead to the next one, as the player proceeds in game and try to access new features or unlock new areas.

In our game, the main level is 3D environment that is our college, and from that level, you are able to access lab rooms and inside each room, there is another level that you could access.

Every level consists of different scenes that run in series. In addition, every scene has its own objects, its own components, its own scripts that run it.
We have put these scenes together to create our educational games.

At any time during runtime, the player is able to access a menu that can be used to go back to the main level.

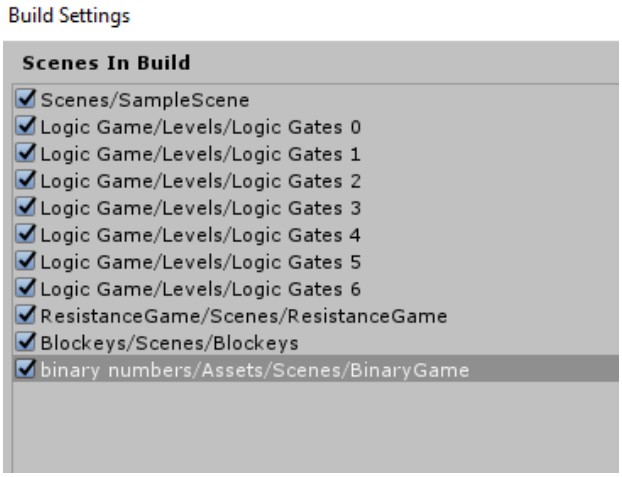

Figure 4.1 The Game Scenes

4.2 Development Team:

Developers can range in size from small groups making casual games to housing hundreds of employees and producing several large titles. Companies divide their subtasks of game's development. Individual job titles may vary; however, roles are the same within the industry.

The development team consists of several members. Some members of the team may handle more than one role; similarly more than one task may be handled by the same member. Team size can vary from 20 to 100 or more members, depending on the game's scope.

The most represented are artists, followed by programmers, then designers, and finally, audio specialists and testers.

4.2.1 Artists:

Game artist is a visual artist who creates video game art, making sure our vision is followed. In our game most of the objects in display are created on Blender and 3DMAX

That includes all the game’s 3D environment, and all the mini game 2D Sprites and other necessary visual assets.

The artist's job may be 2D oriented or 3D oriented. *2D artists* may produce concept art sprites, environmental backdrops or terrain images and user interface. *3D artists* may produce models or meshes, animation, 3D environment and cinematics. Artists sometimes occupy both roles.

4.2.2 Designers:

Game designer is a person who designs gameplay, conceiving and designing the rules and structure of a game. Development teams usually have a lead designer who coordinates the work of other designers. They are the main visionary of the game. One of the roles of a designer is being a writer, to conceive game's narrative dialogue, narrative, and journals, hint system, in larger projects, there are often separate designers for various parts of the game, such as, game mechanics, user interface, characters and dialogue, etc.

4.2.3 Programmers:

Game programmer is mostly responsible for all the running scripts on each game object; the game's code development is handled by programmers. And they overview future development and programmer allocation on individual modules.

4.2.4 Level designer:

Level designer is a person who creates levels, challenges or missions
for computer and/or video games using a specific set of programs

Level designers work with both incomplete and complete versions of the game. Game programmers usually produce level editors and design tools for the designers to use. This eliminates the need for designers to access or modify game code. Level designers often work with placeholders and prototypes' aiming for consistency and clear layout before required artwork is completed.

4.2.5 Testers:

The quality assurance is carried out by game testers. A game tester analyzes video games to document software defects as part of a quality control.

The testers ensure that the game falls within the proposed design: it both works and is entertaining. This involves testing of all features, etc. Although, necessary throughout the whole development process, testing is expensive and is often actively utilized only towards the completion of the project.

Through our work on our educational game, these roles were carried by all of us and we shared same roles as we proceeded through the development, as it was important

to get a sense of how everything works together and figure how to integrate these processes.

4.2 Milestones:

The game design document in our case, our project proposal has set goals for us to reach to make important events or achievements during our production. Milestones mark major events during game development and are used to track game's progress.

Milestones are usually based on multiple short descriptions for functionality; examples may be "Player roaming around in game environment" or "Physics working, collisions with walls"

4.2.1 Prototype

Writing prototype of gameplay ideas and features is an important activity that allows programmers and game designers to experiment with different algorithms and usability scenarios for a game. A great deal of prototyping may take place during design phase before the design document is complete and may, in fact, help determine what features the design specifies.

Prototyping at this stage is often done manually, (paper prototyping), not digitally as this is often easier and faster to test and make changes before wasting time and resources into what could be a canceled idea or project. Prototyping also took place during active development to test new ideas as the game emerges.

Our prototypes were a proof of concept for our ideas, by adding, modifying or removing some of the features.

In our project we used placeholder graphics and other imported or created assets to test out algorithms used in our game and to check if every feature is working as intended without interfering with other running functions in the game.

By iteratively progressing and testing out algorithms and features and replacing placeholders with real assets, it became possible to bring the whole game together as in levels and developed the initial versions.

4.2.2 First playable:

The first playable is the game version containing representative gameplay and assets this is the first version with functional major gameplay elements. In our case it was a functioning main scene where the player could walk, look around with the camera and enter different rooms and interact with different objects.

Figure 4.2 Sample from the first playable

4.2.3 Alpha:

Alpha is the stage when key gameplay functionality is implemented, and assets are partially finished, most of games in alpha have complete features, that is, game is playable and contains all the major features. These features may be further revised based on testing and feedback. Additional small, new features may be added, similarly planned, but unimplemented features may be dropped. We focused mainly on finishing the codebase, rather than implementing additions.

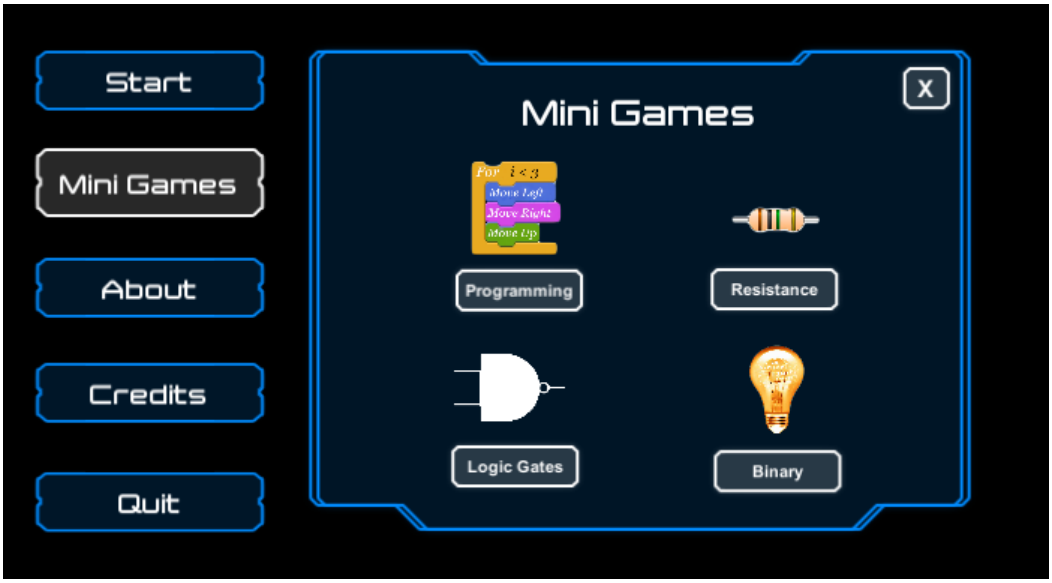

Figure 4.3 Quick Menu for Game

4.3 Testing

Quality assurance is a critical component in game development, though the video game industry does not have a standard methodology. Instead developers and publishers have their own methods. Small developers do not generally have QA staff; however, large companies may employ QA teams full-time. High-profile commercial games are professionally and efficiently tested by publisher QA department.

Our testing started as soon as first code was written and increases as the game progresses towards completion. The whole team will monitor the game after every milestone until as late alpha phase.

Early in the game development process the tested every feature and its compatibility with the whole level and focused on daily feedback for new code. As the game approaches *alpha* stage, more team members are employed focused on testing

As testing took place we observed if any of our goals required changes and adapted accordingly, feedback may determine final decisions of exclusion or inclusion of final features

4.3.1 Functionality Testing:

Was most commonly associated with the phrase "game testing", as it entails playing the game in some form. Functionality testing does not require extensive technical knowledge. Functionality testing was to look for general problems within the game itself or its user interface, such as stability issues, game mechanic issues, and game asset integrity.

4.3.2 Optimization Testing:

Optimization testing ensures that the game runs smoothly on different configurations of hardware and software.

As it is important that the game assets do not cause glitches or misbehaviors that would case the client’s system to slow down or for the game itself to run slowly.

Chapter 5 THE GAME

5.1 Main Game Scene (Abdo Basha Palace)

Figure 5.1 Main Game Scene

5.1.1 Intro

This is a game that simulates the faculty environment, halls and labs.

You will find mini games in each lab to teach you about a different subject for computer engineering department.

The learner can walk around the hall and see the department facilities.

It aims to introduce Engineering topics in a fun learning environment where the learner can interact with the concepts explained for each topic and see it all visualized inside the games to maximize the engagement of the learning experience.

5.1.2 Objectives

- Learn about fundamental engineering concepts in a fun way.
- Learn about logic design, binary, programming and circuits.
- Interact with the concepts explained to recall information faster.
- Improve Learning experience and information delivery process.
- Increase learners engagement with the topics to increase information stored with the help of graphics and visualization of the topic concepts.
- Enhance memory capacity and brain speed.

5.1.3 Skills

- Problem solving skills.
- Hand Eye Coordination.
- Improves attention and concentration.
- Multitasking skills.
- Information recall and retention skills.

5.1.4 Game Scenes

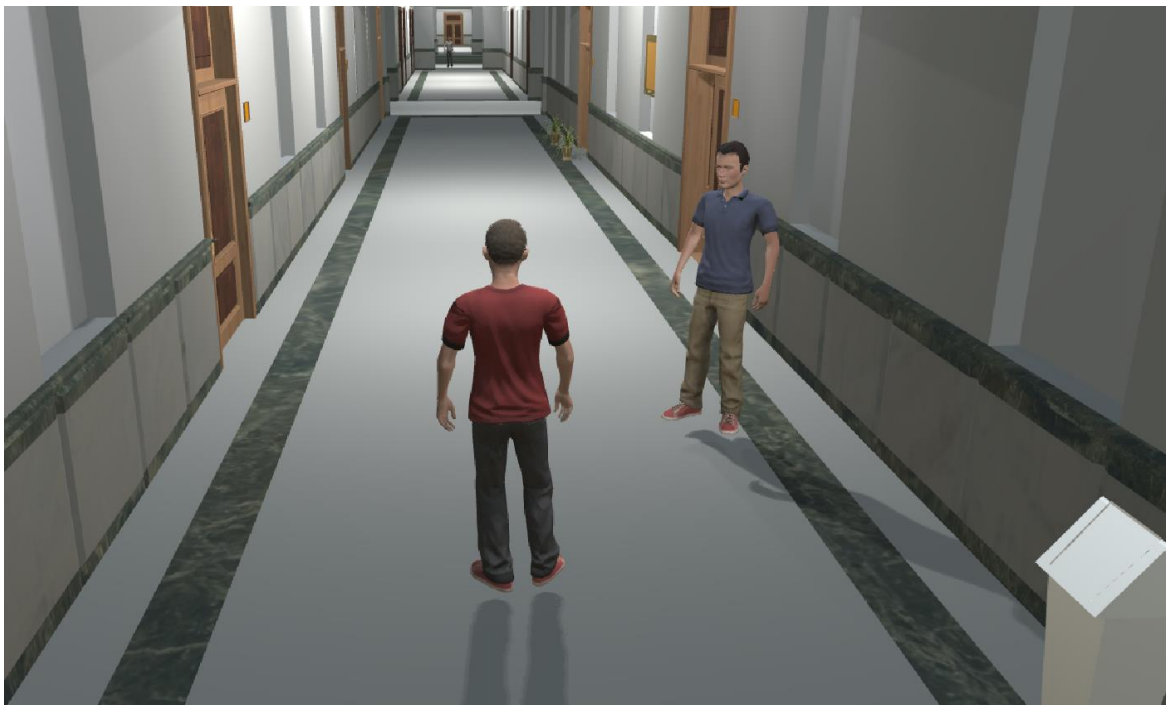

Figure 5.2 Main game scene and the hall of the third floor.

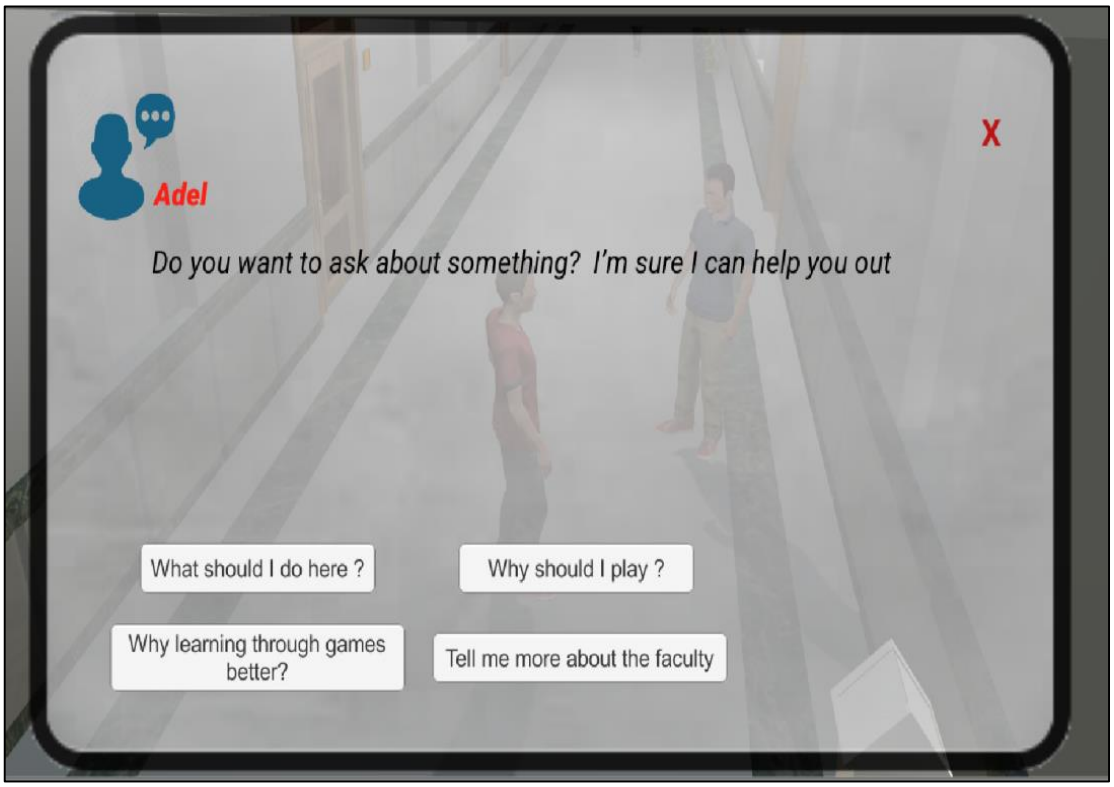

Figure 5.3 Talk to Adel the senior to help you out on what to do about the game.

Figure 5.4 Logic Lab where you can play the logic mini game

Figure 5.5 Circuits Lab where you can play the resistance mini game.

Figure 5.6 Cisco lab where you can play the programming game (Blockeys).

Figure 5.7 Binary lab and drawing room where you can play the binary game.

Figure 5.8 Scenes from the game environment (a)

Figure 5.9 Scenes from the game environment (b)

Figure 5.10 Scenes from the game environment (c)

5.1.5 Importance

The learner will be able to understand and interact with the concept explained in our game and will gain knowledge and skills in four topics which are logic design, circuits, programming and binary numbers.

It also improves the learning experience and doing it in a fun way and with the ability to see the concepts explained and visualized in front of you thus increases the engagement of the learners.

The subjects explained are fundamentals for many courses that the learner will take in the faculty and the projects they will be doing.

These courses are:

- Microcontrollers and microprocessors
- Software engineering
- Image processing and machine learning
- Embedded systems
- Logic Design
- Computer organization
- Electronics

5.1.6 Intended Learning Objectives

At the end of the game the learner should have knowledge about the four subjects explained in the game and has a fast information recall and better learning retention rate and with the ability to solve any problem that concerns with these topics whether it is programming, logic circuits etc. related problem.

5.2 Logic game

Figure 5.11 Logic Game Main Menu

5.2.1 Intro

This game targets young students in the faculty to introduce to them the fundamentals of digital logic subject which is considered an integral part in all technologies that forms our world today from smart phones and laptops to machines, medical devices and microcontrollers systems.

It introduces logic gates like AND, OR, XOR etc. and famous logic circuits like full adder and half adder also implementing logic equations with gates.

It aims to introduce this topic in a fun learning environment where the learner can interact with the circuit and examine the effect of each input and the role of each gate all visualized inside the game to maximize the engagement of the learning experience.

5.2.2 Objectives

- Learn about basic logic gates like AND, OR, XOR etc. and its function.
- Learn about logic circuits like half adder and full adder.
- Learn how to transform logic equations into logic circuits.

- Improve Learning experience and information delivery process.
- Increase learners engagement with the topic to increase information stored with the help of graphics and visualization of the topic concepts.
- Enhance memory capacity and brain speed.

5.2.3 Skills

- Solve logic equations.
- Create and draw logic circuits.
- Problem solving skills.
- Hand Eye Coordination.
- Improves attention and concentration.
- Multitasking skills.

5.2.4 User manual

- Find your way to the logic lab as indicated in the picture below.

Figure 5.12 Logic Game Lab

- Talk to Eng. Ahmed to know more info about the game.

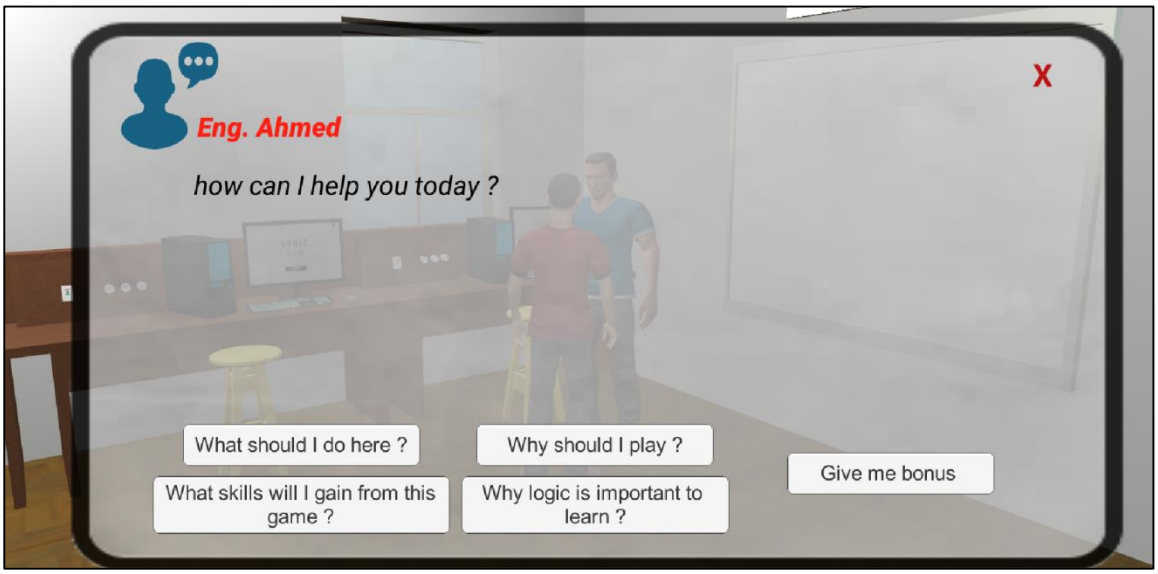

Figure 5.13 Dialog with an NPC (Non Playable Character) inside Logic Lab

- You can start the game by clicking on any of the computers in the lab

Figure 5.14 Launching The Logic Game

- Hit start to play the game.

Figure 5.15 Logic Game Starting Guide

- Go through the tutorial to learn about the logic gates and hit continue to go through it all.

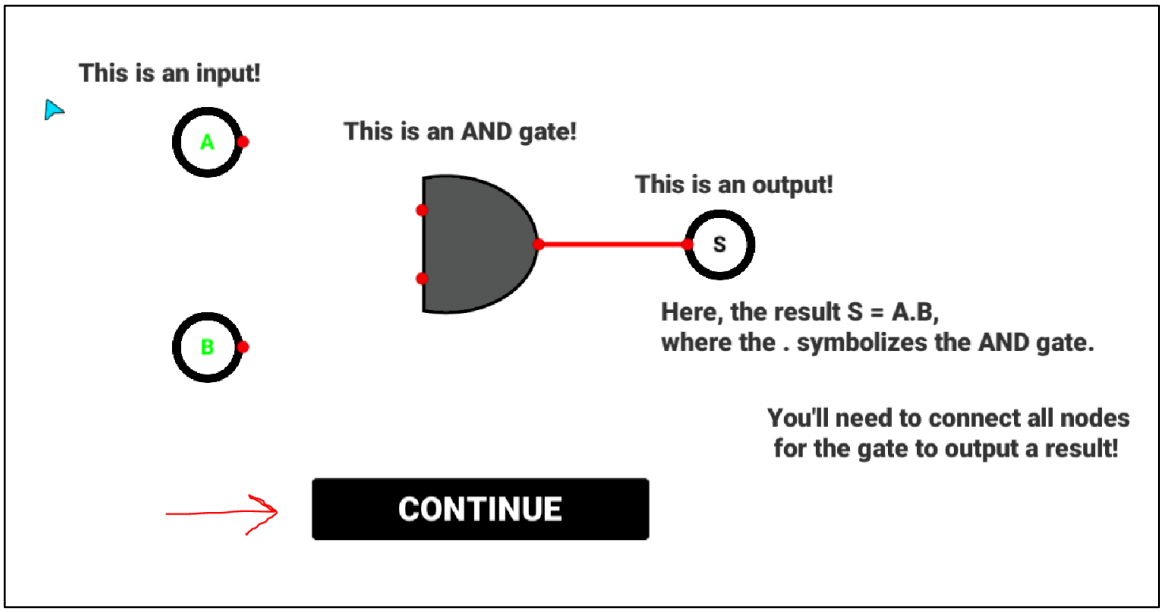

Figure 5.16 A Tutorial Level in Logic Game

- You will need to connect the circuit to match the equation and you can connect the input with the gate by clicking on these red dots and then click on the dot at the gate and they will be automatically connected.

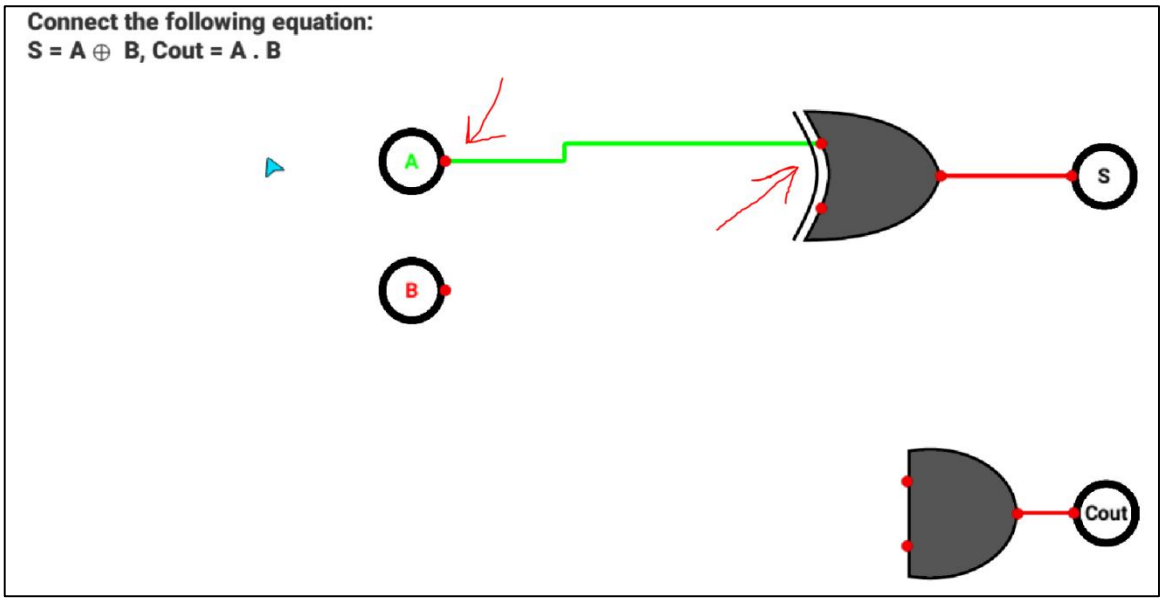

Figure 5.17 Game Instructions

- When you fully connect the circuit it will reveal to you what it is and then you will get a level complete.

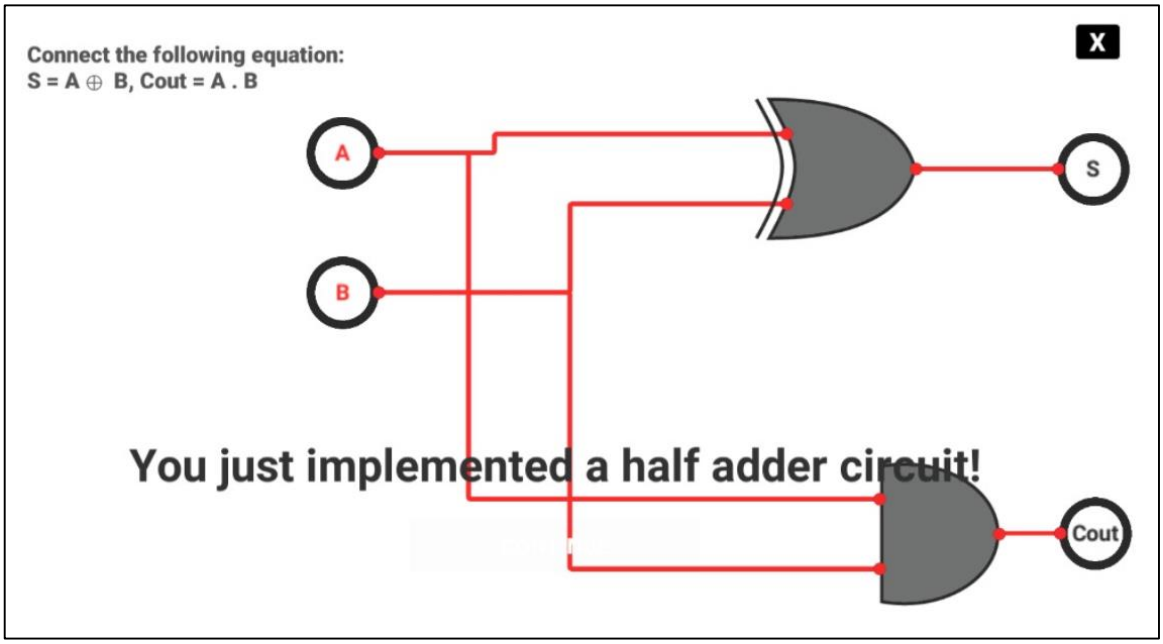

Figure 5.18 Half Adder Circuit in Logic Game

- Hit continue to move on to the next level or hit exit to get back to the game.

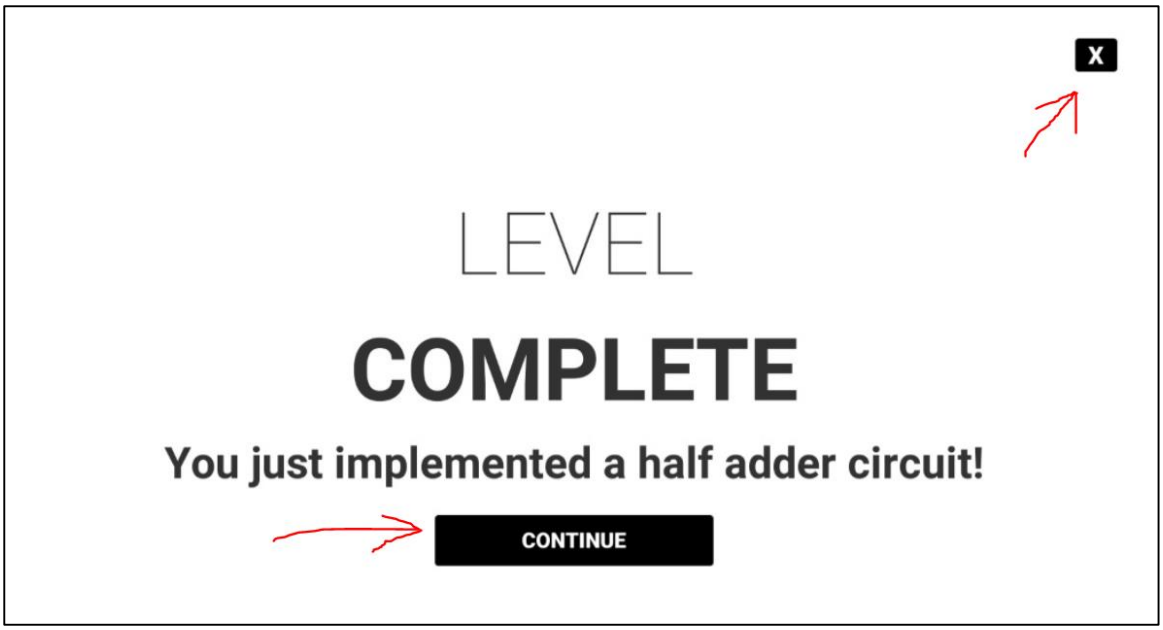

Figure 5.19 Level Complete Menu in Logic Game

5.2.5 Importance

The learner will be able to understand how logic circuits are used to solve engineering problems and understand how logic circuits are analyzed, designed, verified, and tested also is able to understand the relationship between abstract logic characterizations and practical electrical implementations.

It is a fundamental for many courses that the learner will take in the faculty the project they will be doing.

These courses are:

- Microcontrollers and microprocessors
- Embedded systems
- Logic Design
- Computer organization
- Electronics

5.2.6 Intended Learning Objectives

At the end of the game the learner should have knowledge about logic gates and logic circuits and how can he transform a logic equation into a logic circuit and draw it.

Have knowledge about the basic logic gates like AND, OR, XOR etc. and famous logic circuits like full adder and half adder.

5.3 Programming game (Blockeys)

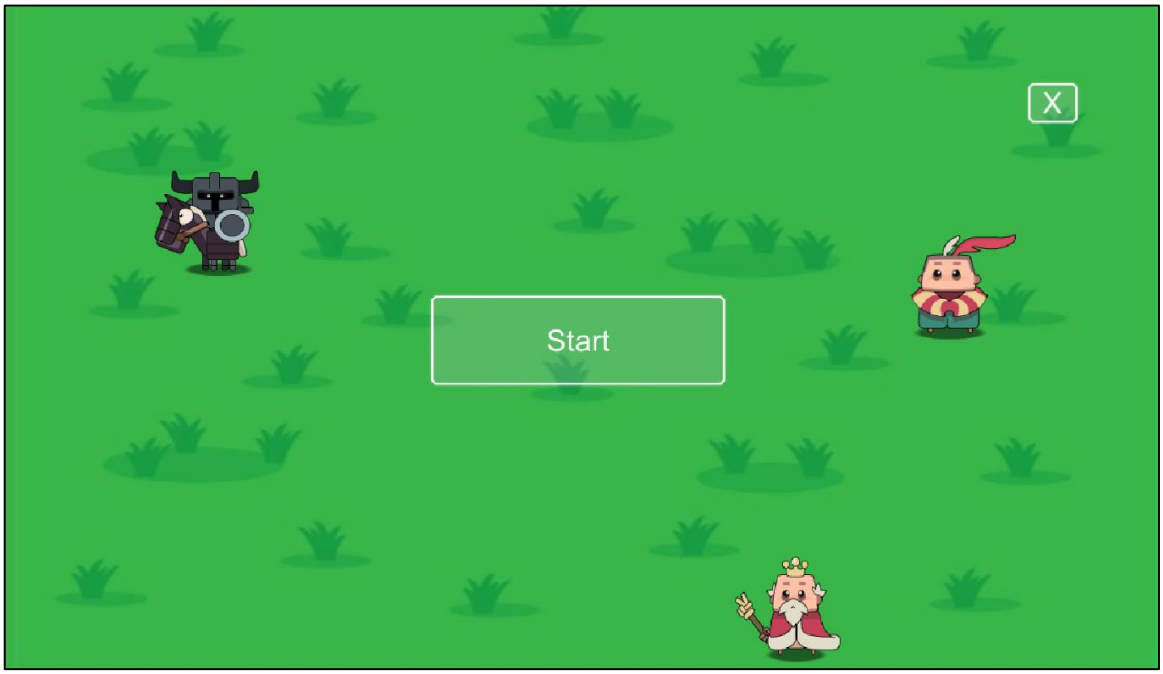

Figure 5.20 Start Menu of Blockey

5.3.1 Intro

This game targets young students in the faculty to introduce to them the fundamentals of programming which is considered an integral part in all technologies that forms our world today in all the industries from smart phones and laptops to machines, medical devices and microcontrollers systems.

It introduces fundamental concepts that are common between all programming languages across all programming specializations like for loops and main functions.

It aims to introduce this topic in a fun learning environment where the learner can interact with the code blocks and examine the effect of each concept and its role on

the code behavior and all is visualized inside the game to maximize the engagement of the learning experience.

5.3.2 Objectives

- Learn about the fundamentals of programming.
- Learn concepts like for loops and main function.
- Learn how to write beginner level program code.
- Improve Learning experience and information delivery process.
- Increase learners engagement with the topic to increase information stored with the help of graphics and visualization of the topic concepts.
- Enhance memory capacity and brain speed.

5.3.3 Skills

- Fundamental programming skills.
- Write beginner level program code.
- Problem solving skills.
- Hand Eye Coordination.
- Improves attention and concentration.
- Multitasking skills.

5.3.4 User manual

- Find your way to the programming lab as indicated in the picture below.

Figure 5.21 Blockey Game Lab

- Talk to Eng. Omar to know more info about the game.

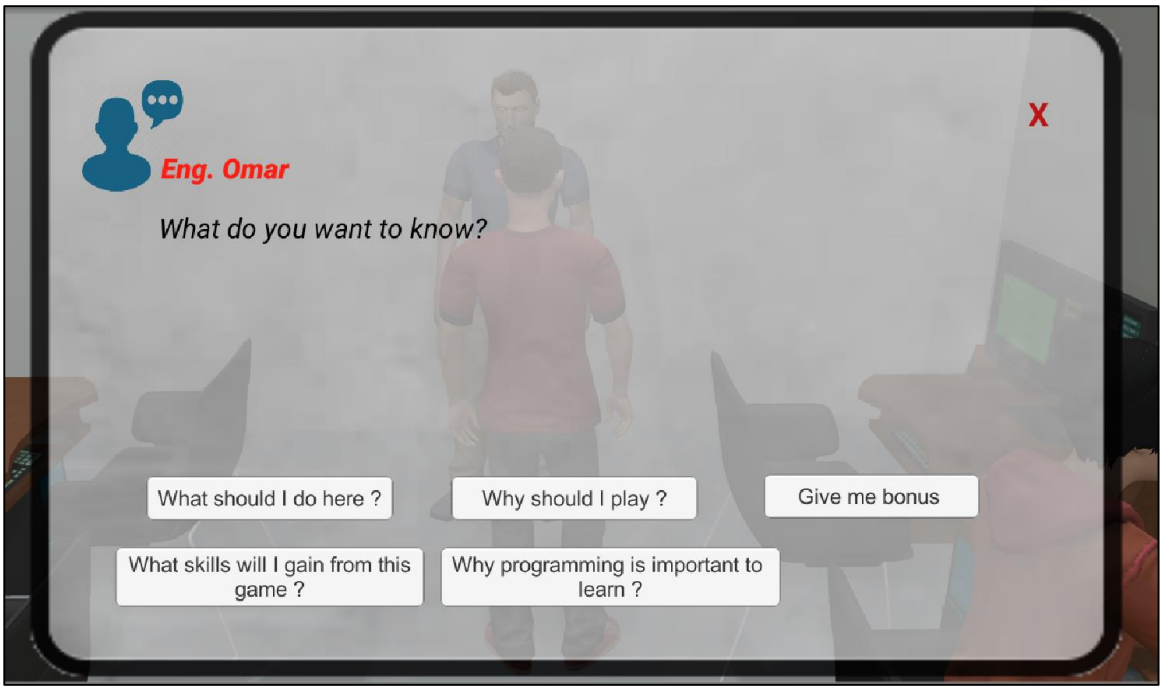

Figure 5.22 Dialog with an NPC inside Programming Lab

- You can start the game by clicking on any of the computers in the lab

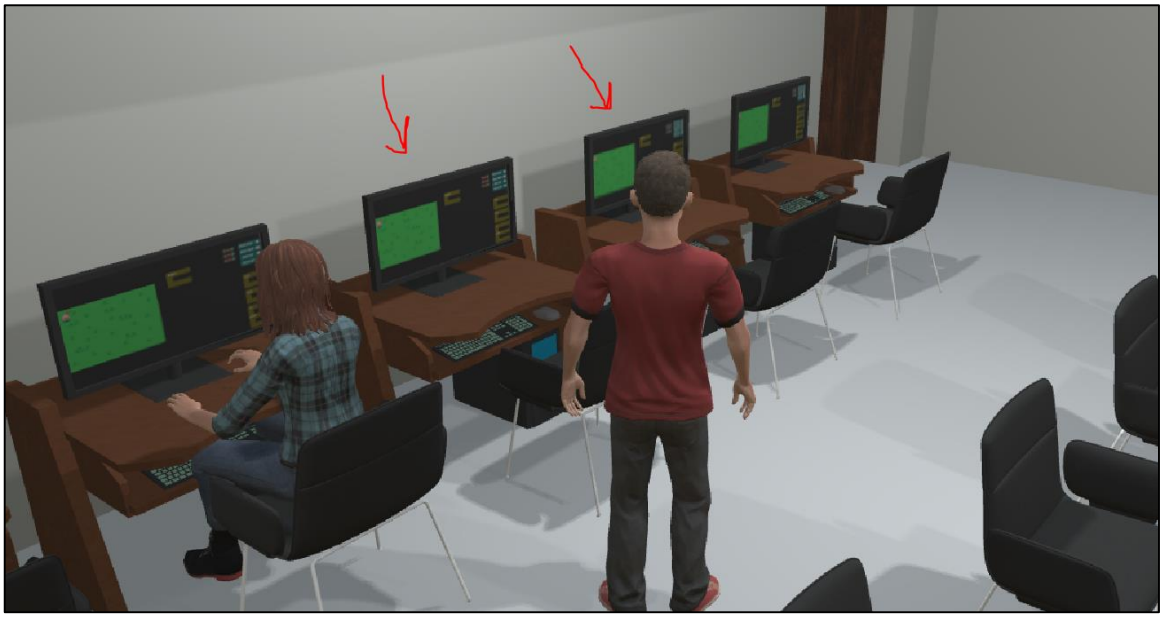

Figure 5.23 Launching Blockey Game

- Hit start to play the game or hit exit to get back to the lab.

Figure 5.24 Start Menu of Blockey

- Drag the code blocks from the right and add them into the main function block to execute them in sequence and the character will move according to your instructions in the main block.

Figure 5.25 Main View of Blockey Game

- After you finish putting the code blocks in the order you like you can hit run to execute the code and see the character move.

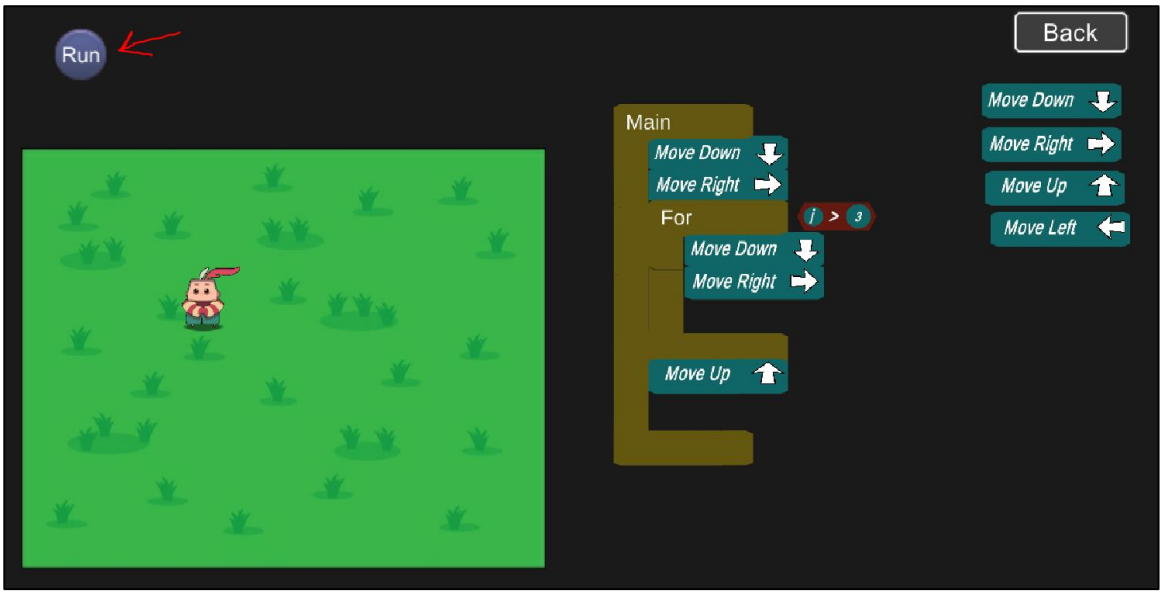

Figure 5.26 Running Block Code in Blockey Game

- You can change the value of “ i ” in the “ for loop “ by clicking on it and adding the desired value and hit submit.

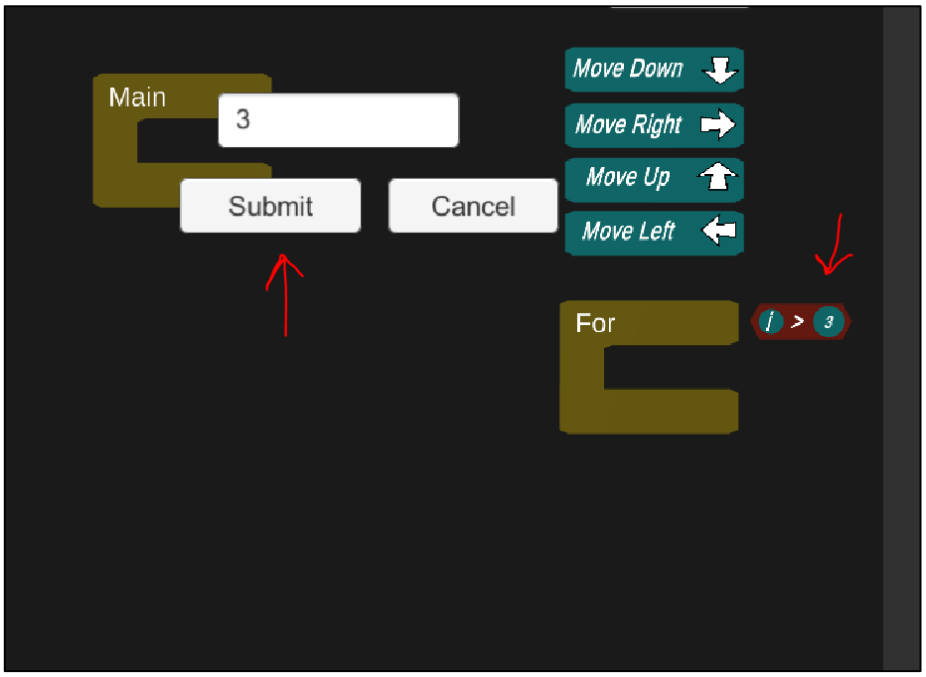

Figure 5.27 Working with For Loops in Block Code in Blockey

- Hit back to get back to the main menu of the game.

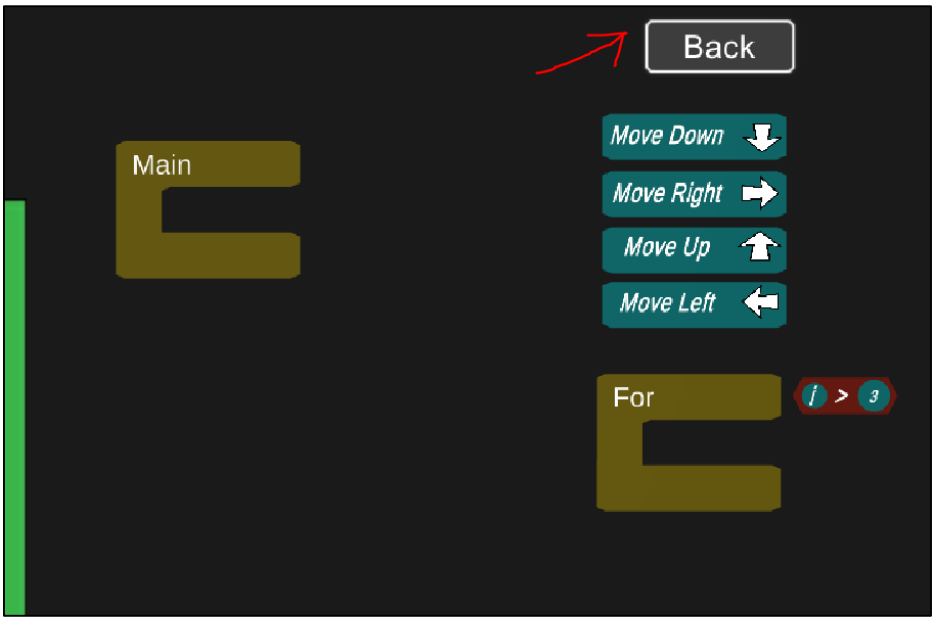

Figure 5.28 Exiting Blockey Game

5.3.5 Importance

Programming is the core of technology which has become an integral part in every industry as well as it’s a profession in high demand in the job market around the world and it is not specific to a certain location so you can get a job anywhere.

Learning about the fundamentals will help you learn quickly any programming language you encounter through your study like C++, Python and Java and many more that will cross your path here.

Also It is a fundamental for many courses that the learner will take in the faculty and the projects they will be doing.

These courses are:

- Software engineering
- Operating systems
- Big data
- Image processing
- Microcontrollers and microprocessors
- Embedded systems

5.3.6 Intended Learning Objectives

The player will gain fundamental programming skills and problem solving skills Also be able to write beginner level programs that implements these concepts and that would help you a lot in the future to learn any programming language you want easily and in no time.

5.4 Resistance game

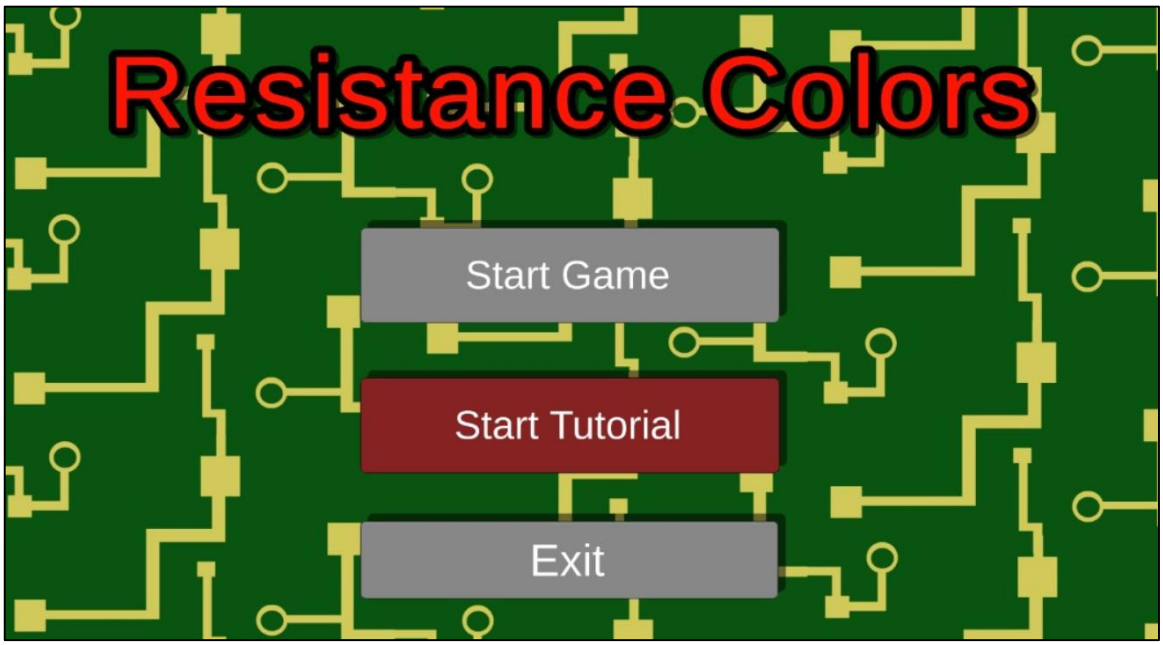

Figure 5.29 Resistance Game Main Menu

5.4.1 Intro

This game targets young students in the faculty to introduce to them a very important component of any circuit and exist in every device and technology you can imagine it is the resistance component in the circuit.

It is an integral part in all technologies and devices that forms our world today from smart phones and laptops to machines, medical devices and microcontrollers systems.

It introduces how the different colors on the resistance bands can affect its value and what each of them represents.

It aims to introduce this topic in a fun learning environment where the learner can interact with the resistance and examine the effect of each color and the role of each band on it and all visualized inside the game to maximize the engagement of the learning experience

5.4.2 Objectives

- Learn about a basic component of the circuit the resistance.
- Learn about its values and how each color on its bands affects its value.
- The ability to calculate the resistance value by just looking at it.

- Improve Learning experience and information delivery process.
- Increase learners engagement with the topic to increase information stored with the help of graphics and visualization of the topic concepts.
- Enhance memory capacity and brain speed.

5.4.3 Skills

- Calculate resistance value by looking at it.
- Choose the suitable resistance value within no time.
- Problem solving skills.
- Hand Eye Coordination.
- Improves attention and concentration.
- Multitasking skills.

5.4.4 User manual

- Find your way to the resistance lab as indicated in the picture below.

Figure 5.30 Directions to Resistance Lab

- Talk to Eng. Hoda to know more info about the game.

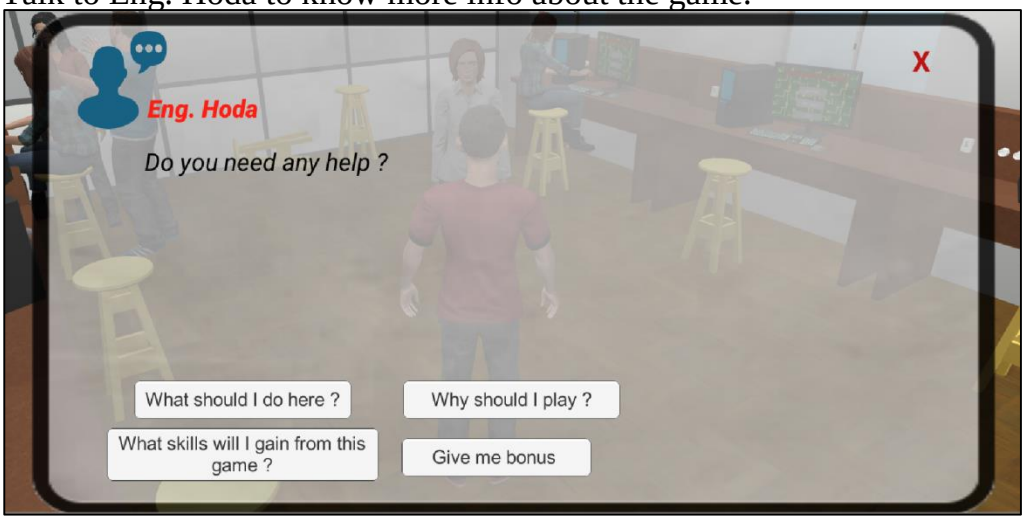

Figure 5.31 Dialog with NPC in Resistance Lab

- You can start the game by clicking on any of the computers in the lab

Figure 5.32 Launching The Resistance Game

- Hit start to play the game or start tutorial to learn how to play the game or hit exit to get back to the lab.

Figure 5.33 Main Menu Instructions for Resistance Game

- Go through the tutorial to learn about the resistance values and how you can play the game and hit next to go through it all.

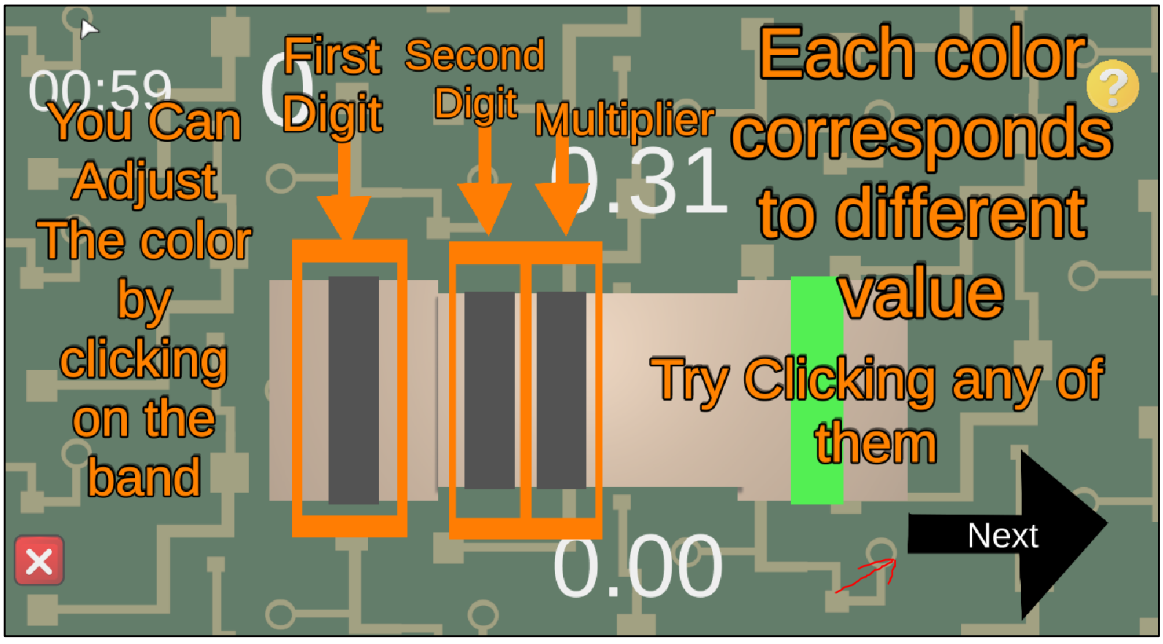

Figure 5.34 Sample from Resistance Game Tutorial

- You can change the resistance value (on the bottom) to match the goal (on the top) by clicking on the bands and change the colors and they match your score increases.

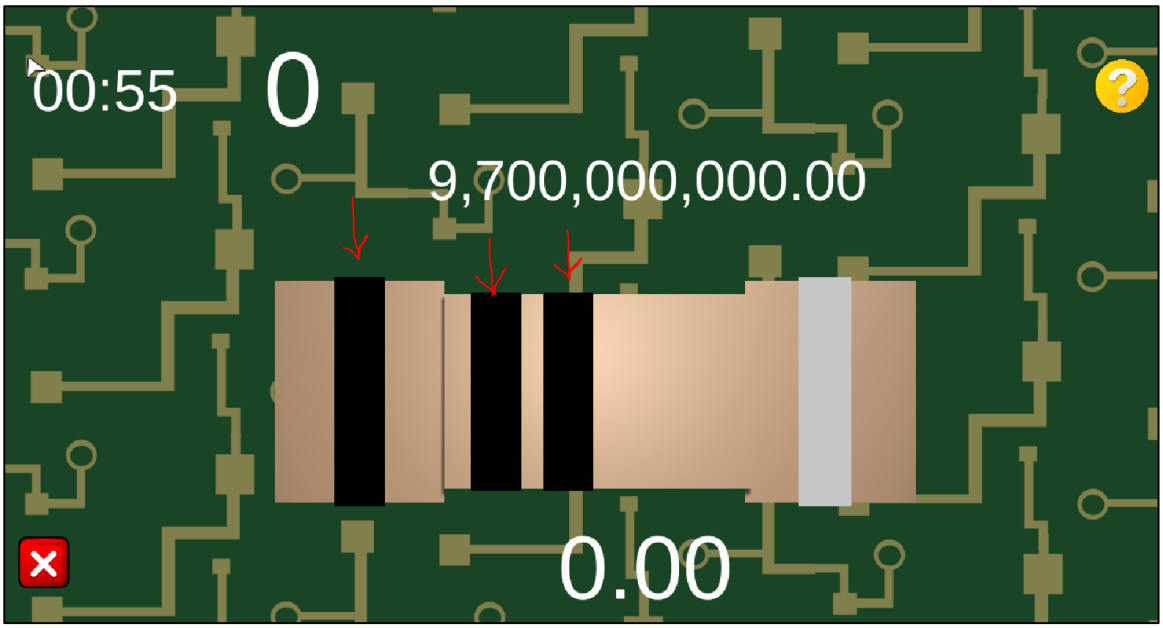

Figure 5.35 Quick Instruction for Resistance Game

- You can hit the question mark icon for quick help image and you can hit the exit button to end the game and see the final score.

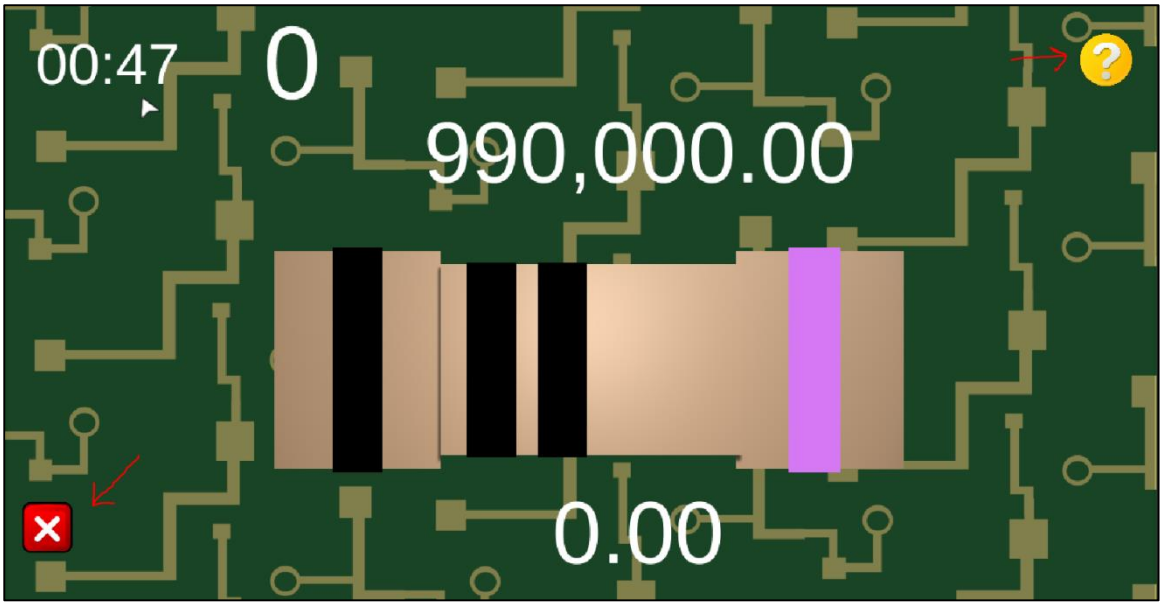

Figure 5.36 Help and Exit buttons in Resistance Game

- When the timer runs out or you end the game you will be taken to the game over screen where you can see your final score and you can hit replay or hit exit to get back to the main menu.

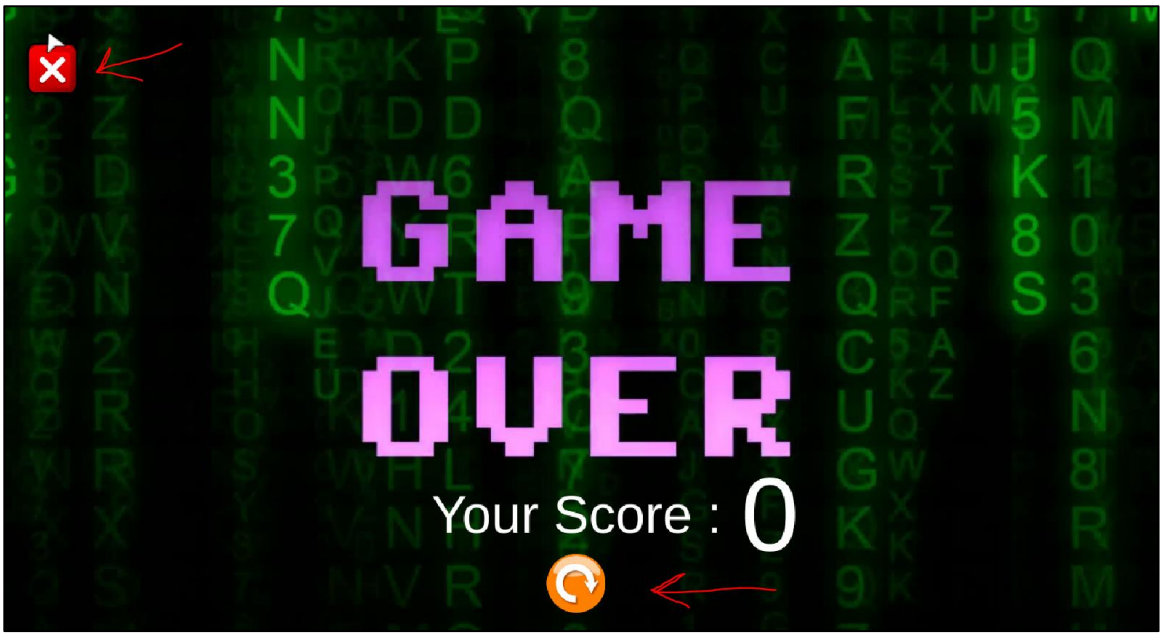

Figure 5.37 Game over Menu in Resistance Game

5.4.5 Importance

The learner will be able to understand an important component like the resistance and how do the colors on its bands affect its value and how can you choose a suitable resistance value for your application.

It is a fundamental knowledge for many courses that the learner will take in the faculty and the project they will be doing

These courses are:

- Circuits
- Microcontrollers and microprocessors
- Embedded systems
- Electronics
- Computer organization

5.4.6 Intended Learning Objectives

At the end of the game the learner should have knowledge about the resistance and how do the colors on its bands affect its value and can choose a suitable resistance value for the application.

5.5 Binary game

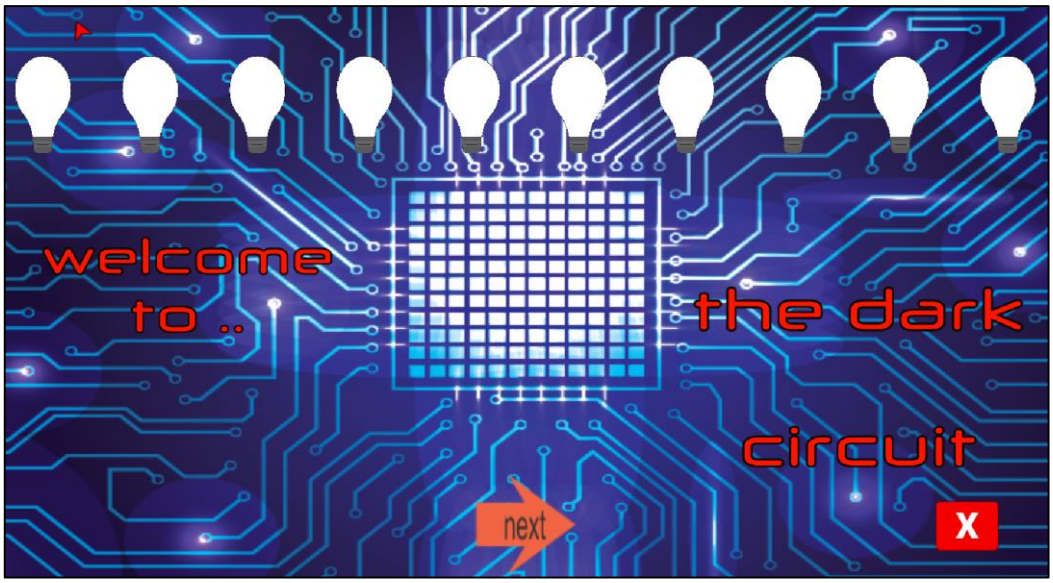

Figure 5.38 Binary Game Main Menu

5.5.1 Intro

This game targets young students in the faculty to introduce to them a very important subject the binary number.

Binary numbers forms the modern technology as it is what the machine language consists of zeros and ones and every program code gets translated into it.

The learner will be able to calculate the value of any binary number by just looking at the location of the bits and see if it has 1 or 0 in it.

So you won't waste any time in the future calculating the value using a calculator while your mind can do it better and faster.

It aims to introduce this topic in a fun learning environment where the learner can interact with the numbers and change the value of the bits and examine the effect of each bit on the value and all is visualized inside the game to maximize the engagement of the learning experience.

5.5.2 Objectives

- Learn about binary numbers system.
- Learn how each bit affects the value of the binary number.
- The ability to calculate the value of the number by just looking at the bits values and locations.
- Improve Learning experience and information delivery process.
- Increase learners engagement with the topic to increase information stored with the help of graphics and visualization of the topic concepts.
- Enhance memory capacity and brain speed.

5.5.3 Skills

- Calculate binary numbers values.
- Write the binary number representation of any decimal number.
- Problem solving skills.
- Hand Eye Coordination.
- Improves attention and concentration.
- Multitasking skills.

5.5.4 User manual

- Find your way to the binary lab as indicated in the picture below.

Figure 5.39 Directions to Binary Lab

- Talk to Eng. Mona to know more info about the game.

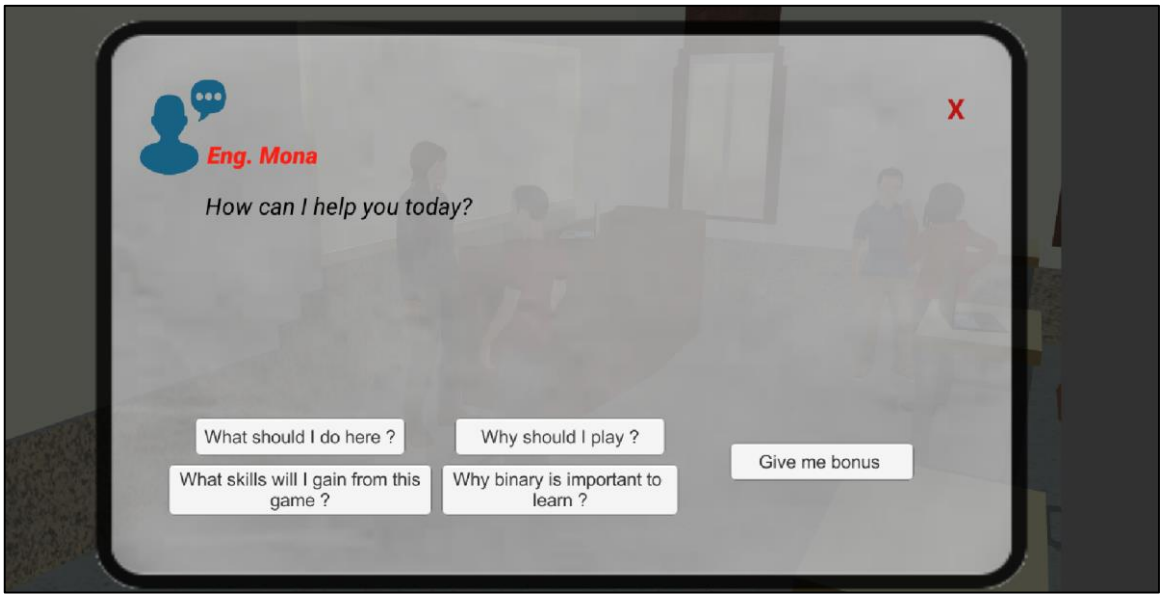

Figure 5.40 Dialog with NPC in Binary Lab

- You can start the game by clicking on any of the laptops in the lab.

Figure 5.41 Launching Binary Game

- Hit next to go through the tutorial and then the game will start and if you want to exit back to the lab just hit exit.

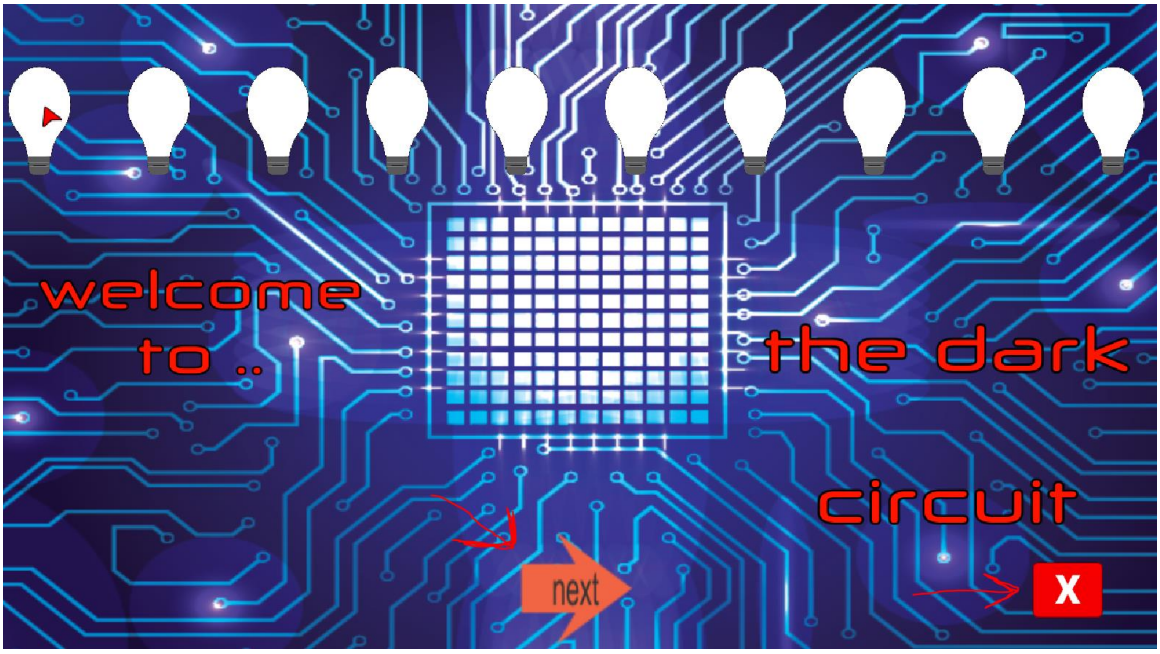

Figure 5.42 Binary Game Main Menu Instructions

- Each bulb here represents a bit and if it is turned on then it's one and it is off then it's zero and the goal here is to light the bulbs in the correct locations so

you can write the binary representation of the decimal number appearing in the middle of the screen.

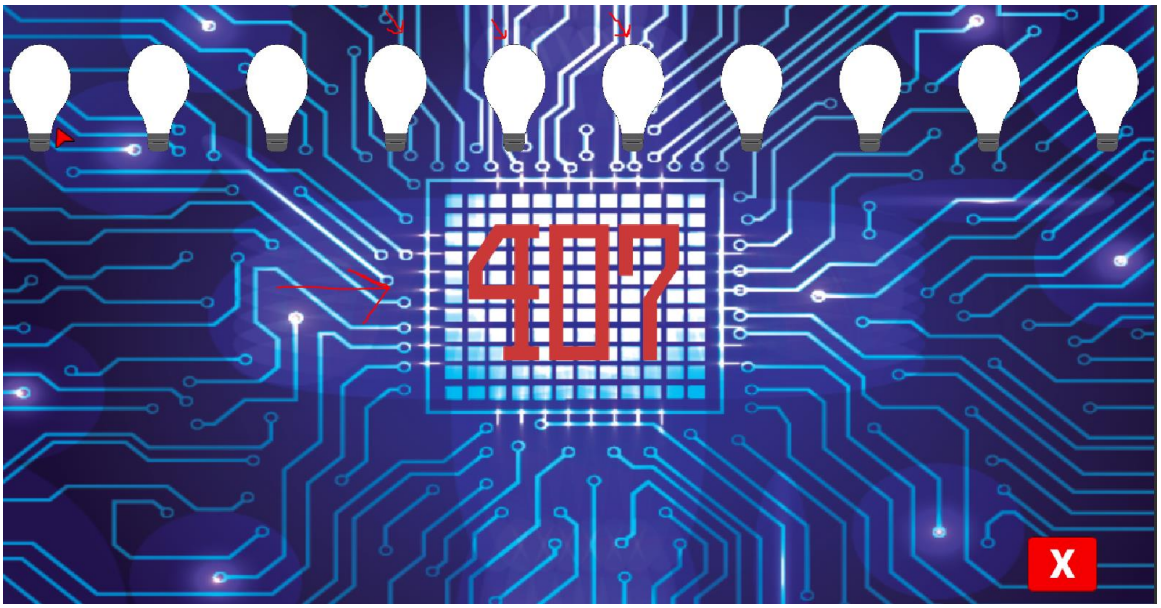

Figure 5.43 Binary Game Instructions

- When you write the correct representation of the decimal number then you have succeeded and you will have the option to play again or exit the game.

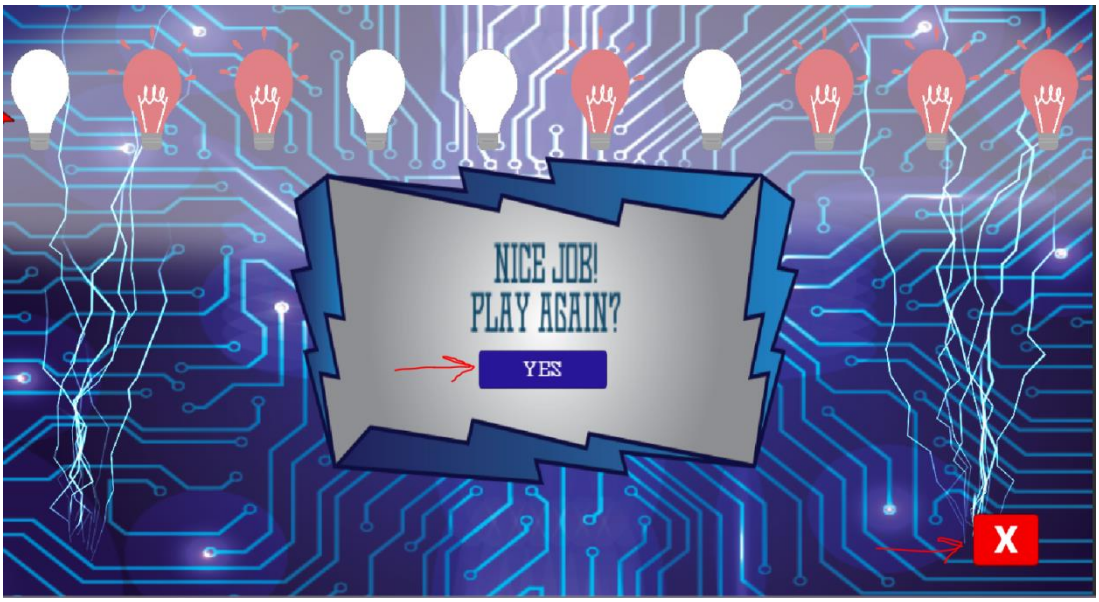

Figure 5.44 Binary Game End Menu

5.5.5 Importance

The learner will be able to understand an important topic which is the binary number system and that is helpful when you're dealing with computers to understand the

concept of the language it speaks that all programs code is translated into binary numbers that the computer can understand and can deal with and that called machine language.

It is a fundamental knowledge for many courses that the learner will take in the faculty and the projects they will be doing

These courses are:

- Logic Circuits
- Security
- Networks
- Microcontrollers and microprocessors
- Embedded systems
- Electronics
- Computer organization

5.5.6 Intended Learning Objectives

At the end of the game the learner should have knowledge about the binary number system and how do the value of each bit affects the value of the number and be able to calculate the value of any binary number in no time and write the binary representation for any decimal value easily.

Appendix A FUTURE WORK

A.1 Games

There are a lot more subjects we wanted to make Games for, to help deepen understanding of concepts of said subjects, but due to the lack of enough time were unable to.

A.1.1 More Logic-Thinking Related Games

When it comes to Logic-Thinking, there is a ton of ideas that can be implemented to help improve the logical mindset of students.

Games like a puzzle Game where you solve different problems like:

- Farmer, Wolf, Goat, Cabbage
- Jealous husbands problem
- The bridge and torch problem

Etc….

A.1.2 Advance Circuit Games

We started with recognizing the colors on a Resistance, but that is the tip of the iceberg.

There are many different Components that goes into an Electric Circuit; each deserves its own explanation on its own.

In addition, of course a game that shows the building of basic circuits, where the student can experiment in a safe environment without the risks that comes with dealing with Electricity in real life.

A.1.3 Hamming Code Game

Hamming code is a set of error-correction codes that can be used to detect and correct the errors that can occur when the data is moved or stored from the sender to the receiver.

It is one of the main methods for detecting errors in sent and received data in networks, as a game it could be applied using a bunch of bottles one which includes a poison and given a list of clues from the person that filled the bottles the player is required to figure which bottle has the poison.

It gives a general idea of how The hamming code works, more so when you associate, the poisoned bottle as the error, the clues as the parity bits, Etc….

A.1.4 Other Departments

Our focus has been mostly on Electric Related Subjects, but Our faculty has three more main Departments with their own subjects that can be taught in many different and creative ways.

A.2 General Features

Some Overall Quality improvement of the final product content that we were unable to implement due to lack of Time and Resources.

A.2.1 Level Editing

Adding the possibility for non-developers to create their own content and add it to the project.

A.2.2 Voice Over

Adding Voice Over for the different dialogues and game texts to facilitate The Student’s understanding through Auditory Education.

A.2.3 Arabic Translations

Making it possible to choose a language at the start of the game, sadly we only managed to make the game in English.

A.2.4 Networking Features

Adding the ability for Students to share their Progress with each other, Leadership boards for High Scores, Etc…

A.2.5 Inventory System and Questing System

The Student collects trophies for completing certain objectives and Quests.

A.3 Graphic Related

We mentioned before that we have made all the used models ourselves, sadly we only managed to do a large part of the Third Floor in the Old building, Which the rest of the old building, and the rest of campus to be made and used in the game.

A.4 Improvement to Existent Games

Most of Our Games have Tutorials to explain how to play; Intended Learning Objectives are made clear, Some Audio and Music for immersion and Solid Arts.

But like anything in the world, there is always place for improvement.

- Adding Auto Hints

  Hints that are given to the student when he is stuck for a certain period.

- Extra modes and Levels

  There are always something more complicated that can be implemented, to give the student the chance to learn even more.

Those general improvements can be added to all the games. There are more specific improvements to be added to each Game.

A.4.1 Resistance Game

Adding a mode where the resistance is given and the student inserts the value of it’s showing.

A.4.2 Logic Game

Adding Custom Creation mode, for the student to create his own Logic Circuits.

A.4.3 Binary Game

Reverse Mode where the student is given the binary code and is asked to insert the Decimal number.

A.4.4 Blockey

Adding a clear goal, obstacles, and Different maps.

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