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Gamifying the Educational Course-Operating System Using Software Engineering Approach

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Abstract: Everywhere across the globe, college education is considered highly important than high school education. Such significant education cannot be taken for granted. For making the students intense and highly competitive, even the educational institutions are under anxiety where they are expected to teach all tricks and trade to make their graduates highly qualified for employability. Educations at each level are either lead by instructors which is broad-spectrum in use or it can be computer based learning. Gamification is one such computer based learning which is applied in almost all sectors where clear understanding of the undergoing process is essential. By considering the merits of gamification, we propose an initiative approach, in which part of the curriculum, a course has been gamified with high instructiveness and provided with appropriate guidelines where ever necessary. It is carried with a confidence that student's involvement and understanding on the course can be achieved to a deeper level. It is implemented, by identifying the potential ability of the student learner and software engineering approach has been carried out in bringing out the various designing elements involved in the gamification technique. An experimental approach was also carried out in order to make an analysis on the gamified course outcome.

Key words: Gamification · Gamification Elements · Education · Operating System · Software Engineering

INTRODUCTION

Education is the foundation of the society which plays an important and continuous part in all spheres of life. Unfortunately, today's education is facing major challenges and problems. Researchers' advocates that school or college dropout figures are increasing every year. Key blockade faced by children that results in dropping out may be due to family circumstances, financial issues, disputes between parents, raise in the tuition fees, admitted in unwilling courses due to the force given by family members, health issues, feeling bored and overwhelmed by studies due to heavy curriculum, finding class work difficult, unemployment problem, frequent change in market demands etc. Children's when given a supportive environment, it may bring out the students engagement and curiosity inside them. This could induce them to make good progress in studies and give their best that in turn fetches them a desired career. Out of the various issues, one that can be resolved by an educational institution is that learning environment can be made enjoyable by including the fun factors into the content that the students learn. The current generation demanding fun factor is missing in the present college environment especially in engineering colleges. Unfortunately, due to result oriented academic approaches, the essential education is followed purely academic without including relaxations. This constant practice might take away the passion from studies as the 21st century children expectations are different. So the academicians must think in improvising the traditional academic practices according to the upcoming generation taste.

The reason for losing the fun factor is because of multi-fold pressures arising from all possible directions. Pressure are from parent's side to score high marks, society pressure on social status, peer pressure in the form of potential competence, teachers' pressure to secure high pass percentage, etc. Pressures from the teachers are due to two fold reasons: One reason is due to heavy competition among colleges and the other one is management pressure. These in turn are reflected at the

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students end and they are being pressurized in studies. This practice eventually drains the brain of students in listening to the vast and great hour lectures together in curriculum courses. Sometimes, at the end of the day, the students may gain nothing. This not only affects their studies, it also affects the career opportunities as the students might lack in technical knowledge.

Solution to the Anxiety problems: In the technological era, children are more inspired by the video games, gadgets, social networking and all sorts of communication devices they own. Nowadays, mostly the human community, especially teens are dedicating a huge quantity of their time in playing video games [1]. A survey at United States taken in 2012 estimates that there were more than 157 million active games [2]. Another recent survey in 2013 has shown a statistical report on every day time spent by playing video games were on average 23 minutes per capita and this is expected to exceed 28 minutes within another 4-5 years [3]. The kind of engagement that happens in games is not that much in case of classroom teaching or at work place. Scientific studies has shown that human beings are able to remember more and more the things they have done wrong rather than the thing they did correct.

Gamification is considered to be a lighter feather problem solving or modifying technique that can be applied in almost all the areas, especially in education. This technique can make education as an enjoyment and it can make the students' to learn while they play. Gamification in the perspective of education means, to take the incentive properties of the games and layering them on top of the educational activities that could motivate students to involve themselves enthusiastically towards what they learn. As gamification is getting flourished, possible parts of the curriculum content can be gamified and the students can be motivated to take it in addition to the traditional classroom teaching method. That's why now-a-days many universities are seeking the helping hands of the game designers in framing the curriculum.

Gamification gives the participant a constant motivation by giving instant feedback on the stuffs they do. It promotes students learning; encourage them to develop a stronger sense of subject knowledge. Traditional learning method makes the learners to do monotonous tasks which may seem to be boring sometimes. The teachers may also have hard time in grabbing the complete attention and involvement of the learners especially during classroom lectures. Traditional learning protocol can be combined with the gamifying technique and simple or complex protocols for the player (student) can be built. The players can explore the activities, can cultivate a self-motivation in clearing each level to move steps ahead to complete the game and can make an individual experiment by planning their next moves which could train them with decision making skill set. This brings out the cognitive skills inside the player which sometimes a traditional teaching protocol might fail to kindle.

The organization of the paper is as follows. Section II explains the possible solutions to pressure in education. Section III describes the game design theory. Section IV describes the motivation for the work. Section V gives the related works. Section VI describes the proposed work and Section VII brings out the experimental analysis and results and Section VIII gives the conclusion.

Game Design Theory: When designing a game, several factors must be taken into consideration out of which 5 factors plays a major role. They are: Replayability, Rewards, Penalty, Game Anxiety and Social Impacts.

- Replaybility is the major game design theory which attracts a player towards it and makes them to play the game again and again. The content of the game, the challenges they face, the supports they were given in crossing the game hurdles etc. decides this factor. When a game is made much complex with head breaking logics it might sound encouraging and interesting to a professional gamer where as an average gamer might find it too boring or discouraged to clear the levels which make them to drop the game.
- Rewards are a direct system that gives a pat on the back of the players when he/she deserves it. It also gives encouragement and motivation. The best and ready reward any player accepts is the score point; hence the scoring system is made as a best golden rule in any gaming. The player often plays with zeal to beat their own high score or the score secured by others. When the player's own score is high, they realize that they are doing things right and feel good. If their own score is less comparative to other players, it kindles the mind of the player to re-evaluate them, try different strategy and forces to achieve high scores. But scoring must not be considered as the only reward element. It depends on the nature of the game that is being developed. The other forms of rewards that most of the online games follows are: powerups, giving additional lives, giving additional hints and clues, rewarding special trophies and other special game items, etc.

- Penalty is the other factor that actually makes the player to understand the mistakes they commit. This motivates the player to proceed in the right direction when they play again the game for successive times. Most fantasy games involve penalties like losing the life, sending to death, trapping in a maze etc. The player must not be punished too harsh which might de-motivate and results in not playing the game again.
- Game Anxiety factor must build sweet pressure on the player and must bring them around the edge of their seat each and every moment. In order to make a good feeling and fulfilment in the game, the player must beat during plays. If the player is unbeatable, they mostly won't get encouraged or the curiosity aspect might be missing in the subsequent plays of the same game.
- Social Impact in any gaming introduced must be a multiplayer game which involves more fun factor among the community of players. For example, common method used by most games is to display the scores on the score board. This burns the ego boost on seeing their friends name on the top of the score board, where the other players in the community ought to create their names on the top level of the scoreboard. Most of the social networking like Facebook brings an immense impact on such scoreboard techniques. Some uses two scoreboarding techniques where one board displays the world ranking of the player and other displays the ranking among the player community alone. This may either result in positive outcome or could leave a negative outcome sometimes.

Motivation for this Work: Gamification is seen as a method that can present a great deal of enhancement in the educational system and is gaining a great gush of attention in recent years. It is as an effective approach to engage existing players and attract new players. Also it had been observed that there is a sudden decline in admission among engineering students especially in the field of Computer Science and Engineering course for the past few years whereas the number of students getting into the tertiary courses has increased since the year 2010, not only in India, but all over the world [4]. Decrease in the number of Computer Science and Engineering graduates, might hamper the global technological development in the near future. More over mostly students find software very difficult to visualize [5]. However, this drawback could be easily thrown away by support of the video game and computer industry. Moreover, the rise of mobile and app-based games development makes the impossible things into possible as well. Rresearchers admit that games cultivates problem-solving and decision making abilities, kindles creativity, innovation and procedural thinking, also promotes collaboration to a greater extent [6] which are considered as important skill set that every 21st century kids' must have.

The proposed work helps in visualizing major computer science concepts that aid in the traditional teaching of software and it could boost up the interest in the field. However, according to Steinkueler and Chmiel [7] the games can never be a substitute for teacher and classroom, but they might replace some laboratories and textbooks. Gamifying subject contents may render a helping hand to those children, who needs extra practice on it, where the teacher may not actually exist when carrying on home assignments, exam preparations etc.

Related Work: A recent survey projects says that most of the publications on gamification is majorly by United States researchers. Prensky [8] supported that electronic games could be used in teaching for students and suggested that it could be normal for the future generations. Gee [9] also emphasized on the potential outcome of video games in learning processes.

Most of the relevant and reviews for game-based learning's used in school level education and college level education can be found in [10-14]. Various courses of studies have been gamified, such as Science [15], Maths [16], High School Maths [17], Foreign Languages [18], Health [19], Computer Science [20], Software Engineering [21-37], Database Management System [38], Graphics Arts [39], Gardening [40] and Electronics Study [41].

Monica *et al*., [42] proposed an innovative gamification techniques for self-training the medical students on anatomy and anatomical topography. This initiative was done in order to give a real time practical exposure to the learners along with theory sessions. This approach gives the medical students' an alternate virtual environment training/practicing where they can get an opportunity to play the role like a real doctor in the simulated framework without losing human lives.

For teaching Polish (which is considered as one of the world's difficult language) as a foreign language, Emilia and Piotr [43] has incorporated an effective and innovative combination of teaching rules within on-line games. The various other situate that adds significant to

education where gamification is in existence are like aiding self-guided for learning [26], assisting the kids for completing their homework assignment [15], for cultivating and strengthening the creativity of students' [44].

Proposed Work

Description and Objective of the Course Context (Case Study): The case study presented here is fourth semester course in Computer Science and Engineering "Operating System". The major objective of this course is that each computer professional must have a basic understanding of how the operating system works, controls the various computing resources attached to it and services provided. The syllabus framed by the university, provides an introduction to the Operating System basic concepts, the structure and functions of Operating System, processes, threads, scheduling algorithms, concurrency, deadlocks, memory management schemes, managing input/output and file systems. Along with these, for a wider understanding, real-time operating system case studies was also included which could easily help the students' to obtain sound knowledge and exposure to the real time system where the learned concepts are put in existence. After the completion of the course, the students' must be able to design and implement their own operating system.

This work has been proposed by considering the following three features which could provide a balanced approach in taking care of the examination result and could bring a deep engagement of individuals towards studies round the clock:

Strengths and Weakness of the Students: In a classroom environment, there are different categories of students and they all need individual attention. Mostly the students are categorized based on the individual Intelligent Quotient (IQ), needs and interest towards studies. Taking these aspects into consideration, the entire classes of student's (2 sections, 70 each) were divided into three categories as: a) Slow Learners – Students having less IQ (comparatively), less motivation and less interest towards studies. So they pay less attention in studies. They do not learn the entire syllabus during examination.

- Average Learners – Students with average IQ, interested in securing good grade with minimum effort. They try to cover the entire syllabus for examination, but sometimes they may also fail to cover it.
- Good Learners – Students with more IQ, tries to secure high grades, potentially apply the complex thinking and improve their problem solving abilities. They could possibly explore beyond the curriculum and may bring innovation ideas out of their learning.

It has been identified (from their previous performances), that the good learner concentrates well in studies and they need to be given special considerations while comparing with the other two classes of learners. The average learners fall in a category between slow learners and good learners. If they understand the subject well, they could secure pass marks, else they might fall on to the other side of the result. These students must be given extra attention. The slow learners, if motivated properly, they could be added to the list of average learners. This proposed system might help the slow learners to learn at least the important concepts of the course rather than being studying nothing.

Developing Teaching and Learning Approach Based on the Student Needs: A good casual gamification technique must be easy to learn, it must not involve any complex controls like key board commands for interaction where a mouse could be used and must be short time commitment where the player might be able to see the result displayed for the game played. It must also be adapted based on students' needs. At the same time the effectiveness of teaching and learning must not be compromised. The game designed here met the unique teaching and learning needs of the students. New concepts were introduced to the students during the course of learning in a gradual progression. At the initial level of the game, the 3 categories of students (slow learners, average learners and good learners) were given a similar fashion of treatment as they are new to the course being taught. Initially a student cannot master a concept as there might be a gap left in their knowledge base, the challenges they face in understanding the complex concepts etc. To master the complex concepts, this digital gamification learning through scenarios and analogy might help the student players to master the concepts by repeatedly playing the complex concepts levels.

Engaging Curriculum Choices: As an initial step, most important concepts that the students' need to understand was picked up. The choices of topics chosen were based on twofold things. First, the importance was given to frequently asked questions in the university examination, secondly, to the career (interview point of view). With this

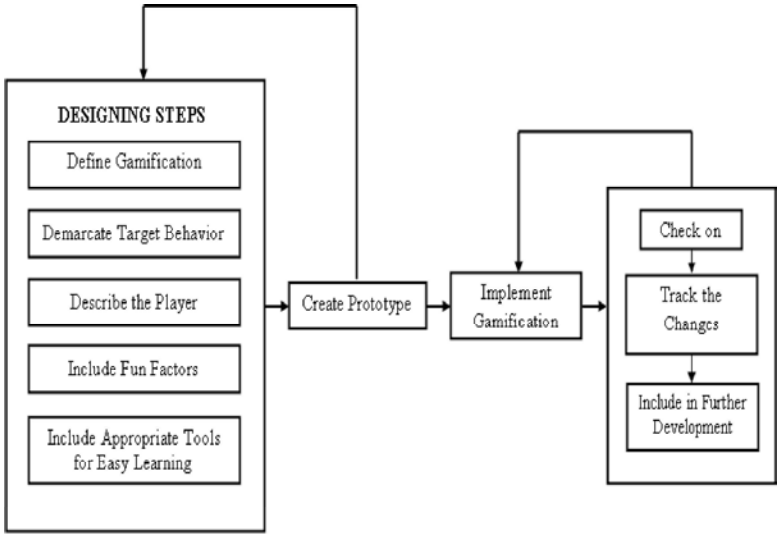

Fig. 1: Approach followed in the proposed system

Table 1: Traditional approach terminologies vs gamified approach terminologies

Traditional Approach	Gamified Approach
Course – Operating System	Game – OSGame
Credits	Points
Textbook	Learning Kit
Units	Stages
Topics	Levels
Instructor	Designer
Test / Examination	Mastering the Levels
Grades	Badges

dual consideration, the concepts like various process scheduling algorithms, deadlock, paging and segmentations, multithreading were taken for gamification. Also software engineering approach has been carried out to bring the gamification product. The Table 1 gives a comparison between the traditional approach terminologies and gamified approach terminologies which is helpful for giving out the terms used in the designing and other stages.

Gamification Designing: Gamification designing has its own challenge in the creation of the rules and the game content. The software engineering methodology followed in this proposed system is prototyping, an iterative approach as shown in the Figure 1.

This approach involves passing through the entire software development life cycle of designing, implementation and evaluating in iterative fashion. More number of iterations was followed for getting a final better result. The various phases that have been undergone are as follows:

Requirement Gathering and Analysis: In this phase, the game's working elements were identified and analysed. The atomic elements of game designing are:

- Player
- Player Structure
- Gaming Objective
- Rules (Mechanism)
- Information to be reviled during the course of play at each level
- Sequencing
- Theme (or narrative, back-story, or setting)

Player: The player is the key element of the system. How many players does the game support? Must it be an exact number or a variable number? Can players enter or exit during play? How does this affect play? What is the association between players: are there teams, or individuals? Can teams be uneven? Based on these key questions, the requirements were identified and analysed.

Player Structure: The player structure is formed based on the analysis made as per Table 2 given below:

Gaming Objective: The game objective is the purpose of the system being developed and it must be made clear while designing a new game. Once the objective is framed, then the other formal elements can be easily defined. Few common objectives considered are listed in Table 3:

Rules (Mechanism): There are three categories of rules: i) Setup, things to do at the beginning of the game, ii) Progression of play, what happens during the play and iii)

Table 2: Player Structure

Player Type	Structure	Example
Solitaire	1 Player vs. The Game System	Solitaire, Minesweeper
Head-to-Head	1 Player vs. 1 Player	Chess
PvE	Multiple Players vs. The Game System	Knizia's Lord of the Rings, Arkham Horror and Pandemic
One-against-Many	1 Player vs. Multiple Players	Game Scotland Yard
Free-for-All	1 Player vs. 1 Player vs. 1 Player vs. …	Monopoly to multi-player death match (Board games)
Separate Individuals against The System	1 Player vs. a Series of other Players	Blackjack (Casino Game)
Team Competition	Multiple Players vs. Multiple Players [vs. Multiple Players…]	Bridge and Spades
Predator-Prey	Players form a (real or virtual) circle	Assassination, Vampire: The Eternal Struggle (Trading-Card Game)

Table 3: Gaming Objectives

Game Objective	Aim	Example Game
Capture or Destroy	To eliminate all the opponent's participant from the game in order to win	Chess, Stratego
Territorial Control	To focus on having superior power on certain areas of the board, not necessarily on destroying the opponents	Diplomacy
Collection	To collect some objects to win the game	Rummy (Collecting sets of cards), Bohnanza (Collecting sets of beans), Spyro (Video game aims at collecting the object scatterd throughout the level)
Chase / Race / Escape	To run towards or away from something	Super Mario Bros
Spatial Alignment	To position the elements	Tic-Tac-Toe, Pente, Tetris
Build	To build the resource to a certain point	Settlers of Catan

Resolution, the conditions that cause the game to end. Some rules are automatic that are triggered at certain point without player's interaction and some rules are defined by the action that the player takes in the game.

Information to Be Reviled During the Course of Play at Each Level: Information defines the varying amount of details that are available to the player. A few games like chess offer total information to the players at all time. Some games like Poker, Card Game gives information to all players, but is entirely private to the individuals. In some, one player can have their privileged information than the other players, like Scotland Yard. Some other games like Clue and Sleuth, contain information hidden itself from all the players.

Sequencing: The sequencing decides the order in which the players need take their actions, the flow of action decide the turn structure in multiple player environment. For example, some board games like chess are purely turn-based; other games are turn-based with simultaneous play can be allowed between the multiple players. For designing the turn-based games, the time limit must be specified explicitly to force pressure on the multi-players.

Theme (Or Narrative, Back-story, or Setting): To provide an emotional connection with the game a narrative or back-story is a good choice of element. A well-chosen theme make the game easier to understand and easier to play. The narrative option helps some way to memorize few concepts in a good way.

During analysis, some questions asked were:

- What are the game's formal elements?
- What are the results of the formal elements?
- Are there any challenges that the player faces at each levels?
- Is the game re-playable at any stage or level?
- What is the "core" of the game that represents the main "enjoyable" part?

At the end of requirement gathering and analysis, the elements needed for the system was identified. In successive iteration, new requirements were identified and prioritized. The possible element identified during iteration is listed in Table 4:

Designing: Gamifying environments with ideation contests include three features: i) achievable goal that is to be met by the learner, ii) obstacles that create challenges and difficulty for the learner to explore their potential and iii) competition which enables them to compete among themselves and with their peers. Such gamification process is complex and it involves designing multiple stages. In this phase, the game design for this initiative was modelled based on MDA (Mechanics,

Table 4: Elements identified during requirement gathering and analysis for the proposed system

Element (s) Chosen for the Proposed System		
Element Type	Chosen Element	Justification for Choosing
Player	Single Player System	The player can enter and exit the system anytime during play. This might help them for relaxing as prolong usage of computer might cause eye irritation.
Player Structure	Solitaire	As the player is to learn new concepts, need much concentration. While playing with multiple groups it may lead to distraction.
Gaming Objective	Territorial control	In order to master the course being learnt, one must focus on pursuing superior power on certain areas of the course content.
Rules (Mechanism)	-	Setup – Player (Student) must have attended classroom lectures. The progression of play and resolution varies at each level.
Information to be reviled during the course of play at each level	-	In order to have an excitement, the information about the course is reviled at each level of play.
Sequencing	-	Solitaire player structure, so no need for sequencing.
Theme (or narrative, back-story, or setting)	Narrative and Story	Narrative – Used to describe the concepts. Story – Used to describe real time concepts like deadlock, scheduling algorithms.

Table 5: Game mechanics layer element used in the proposed system

Game Mechanics Layer Framework Elements	Purpose in this Software Development
Points	Points are the main scheme of reward used in any educational courses. In order to earn points, the player must complete the tasks. During each level progression, for each correct hit, the player is given with points, as a token of appreciation.

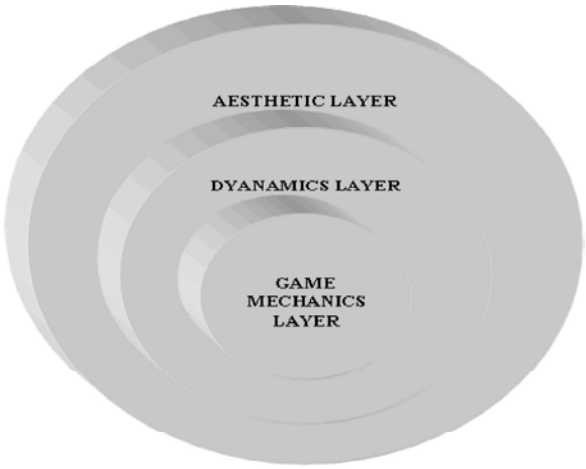

Fig. 2: Layered designing approach

Dynamics, Aesthetics) [45] framework. Considering these basic game elements, the software development is modelled into three layers:

- Game Mechanics Layer
- Dynamics Layer
- Aesthetic Layer

Designing starts with the Mechanics layer at the core surrounded by the dynamics layer and then is followed by aesthetics layer on the surface as each layer grows out of the one inside it is shown in Fig. 2.

Game Mechanics Layer: This layer is like the heart of the proposed framework that defines the entities and their relationships involved in the gamification. The major benefits of the gaming mechanics are to increase player engagement and to reach higher motivation level. This framework is designed with the mechanism of identifying the player's achievement and the rules that provides the rewards. The Table 5 shows the game mechanics layer element used in the proposed system.

Dynamics Layer: This layer describes the play of the game as when the rules are set in motion. Positive feedback loop is used in designing because of twofold reasons: one it helps to end the game quickly as soon as the player is succeeding as a winner and secondly, it puts off the fire of being getting bored due to long time engagement in the game. Table 6 shows the dynamic layer element used in the proposed system.

Aesthetic Layer: This layer covers the look and feel, sound to be produced during play, images to be displayed and the narrative aspects were designed. Table 7 shows the aesthetic layer element used in the proposed system.

Additional mechanics, new systems, additional game objects and new ways for the objects to interact with one another were identified in successive iterations and designed.

Table 6: Dynamics layer element used in the proposed system

Dynamics Layer	
Framework Elements	Purpose in this Software Development
Positive Feedback Loop	For reinforcing relationship

Table 7: Aesthetic layer element used in the proposed system

Aesthetic Layer	
Framework Elements	Purpose in this Software Development
Story	From Level 1 to 5, for introducing various operating system concepts, a narrative description was given with audio-visual representation
Reward	Rewards were given for the player achievement. They are given in the form of points, as it is simple to understand. A visual representation of the reward to the player was produced at each level

The features supported by the proposed work are:

- Player (student) can go through the concepts in each level. After studying those, they can take the challenges in the form of tests, assignments or practice sessions.
- Player's are given with a chance to make multiple attempts on each level. Re-taking the levels gives ample chances to different categories of learners' with a belief, that it might make them to give their best by the end of the course. Sometimes, failing in gaming level might provide a better opportunity for improvement and detail analysis on the course content can be done by the player.
- Rewards in the form of bonus points are also given at each level for constant motivation.

As part of the designing, five levels were introduced as follows:

Level 1: Shoot to learn

Level 2: Find the situation

Level 3: Capture golden egg to schedule

Level 4: Match the right hint

Level 5: Test yourself (Self Assessment)

The proposed work is designed in such a way, that a student is promoted to move on to the next level, only if he/she earns a certain amount of points in the current level. Hope this assures that the student learns something worthwhile at each level.

Development and Testing: The proposed system has been developed using. NET(C#) front end and SQL Server as backend. It consists of 5 different levels and each level is developed as separate module. After development, the system is tested for correctness by writing suitable test suites. The system has been tested by using both black-box and white-box techniques. The implementation details of the 5 levels in the proposed system are as follows:

Level 1 – Shoot to Learn: The first level is similar to shooting game, where the player is made to learn the basic concepts of the operating system. Each player is given with an individual login, which is used for maintaining the individual's score in a database for assessment. Step-by-step lessons on the basic concepts like introduction to operating system, computer-system structure, operating-system structure, process, thread, memory management and file system was given with a series of narrative tutorial. Few mandatory solved exercises (tutorial) have been given to ensure that the player is confident to take self tests to complete the current level. After taking the tutorial and glimpsing at the solved exercises, the player can test his/her level of understanding of the studied concepts by answer simple objective questions at the end.

During self-test, the player is supposed to enter the number of questions he/she is willing to answer and is free to select the topic. Question on minimum of five concepts must be attempted by the player in order to pass to the next level. According to the number of question entered, that much number of objects to be shot will appear on the screen. The object used in this game design is duck. The player has to capture the object (duck) in order to answer a question. After a perfect shot on a duck, the objective question with multiple answers will be displayed. The player must select an answer. In case of the right answer, corresponding object (duck) disappears from the screen meaning that out of the selected number of questions, a correct attempt was made. When the player answers all the questions correctly, then the player can continue to the next level. In case of wrong answer

Fig. 3: Big brain academy

Fig. 4: Login page

the object does not disappear from the screen and the player could not move on to the next level. For each correct answer, the points will be incremented.

In order to motivate and engage the player, awarding of negative marking is not entertained. Whenever the player shot the duck and answered the question wrongly, he/she will be given another turn to answer some other question. By this way, the student can learn the concepts thoroughly and can have a firm basic knowledge on the subject. Randomization of questioning has been done on repeated playing of the same level.

As this is the basic level, the type of reward as per the core gamification strategy awarded is points. Even thought the points are the very basic game elements, they are considered as the major motivational mechanics that function as the immediate positive reinforcement and are seen as the virtual rewards. In addition to points a gift is awarded to the player after the successful completion of level 1. It is the player can grab a car key in order to open the road to next level. Fig. 3 to Fig. 7 shows the first level workings.

Level 2 – Find the Situation: On successful completion of level 1 and after obtaining the car key, the second level, narrates various analogy and real life situation to learn various concepts in the operating system such as process life cycle, thread life cycle, classical problems of synchronization like bounded-buffer problem, readers-writers problem, dining-philosophers problem, deadlock, banker's algorithm (deadlock avoidance), swapping, paging, segmentation, dynamic memory allocation problem's solution (first-fit, best-fit and worst-fit) and fragmentation in detail. To add a pleasant feel, along with narrative description audio-visual representation was also presented. As an example, the real life situation used to explain deadlock concept is road traffic. Fig. 8 shows such a situation.

Fig. 5: Shoot to Learn

Fig. 6: Duck Captured

Fig. 7: Duck Shot

Fig. 8: Real life road traffic

The object used here is car and with the help of the grabbed key in the first level, the player can continue to travel in the car. Some meaningful stories/analogy is used to describe the deadlock situations which are narrative. Both text level description and audio description about the concept are available for analogy narration. Player can pick his/her choice to learn about the concept or can have both. After completion of the tutorial, the player can test himself/herself by answering a set of multiple option questions.

The player is free to select any sub-levels among three: i) Beginners, ii) Intermediate and iii) Advanced. Depending upon the sub-level chosen, the difficulties of questions goes in the increasing range from beginner level to advanced level. In this level, to add zeal, the player will be facing some challenges life traffic blocking,

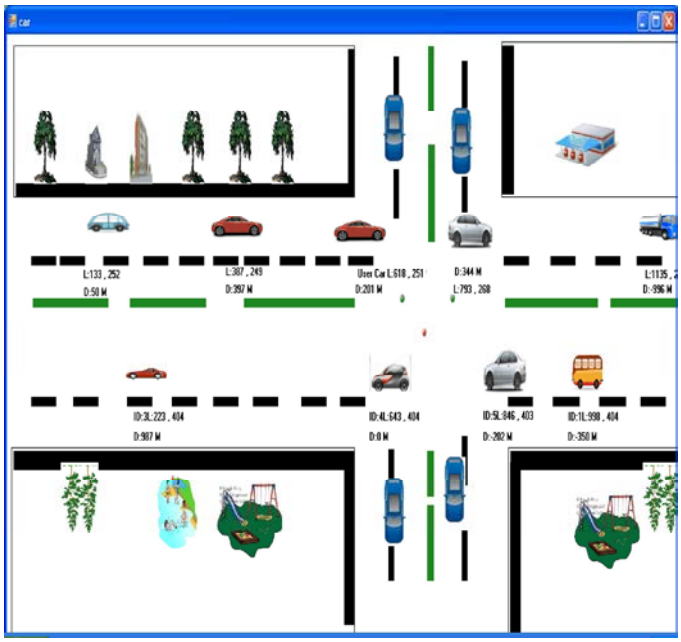

Fig. 9: Learning the concept of deadlock

Fig. 10: Fuel emptied

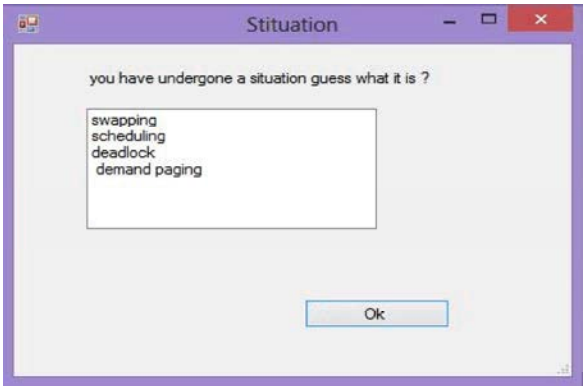

Fig. 11: Sample question rose for earning gold coin

fuel emptying during driving the car. For example, if the car is left with less fuel or no fuel an indication will be thrown to the player. In order to fill the fuel, the player needs to answer few extra questions from the learnt concept. For every correct answer, the player is given with gold coins with which he/she can earn and pay for the fuel to continue the car ride. After filling the fuel only, the player can be able to move his/her car from the stopped position.

Fig. 12: Fuel filled after paying for it with the earned gold coins

Many such challenges lie on this level and after fetching a target score only the challenging blocks faced by the player will be cleared and the player may proceed with the game. A time indication is used in this level, in order to give some thrilling experience to the participant. The other concepts explained in this level are: States of a process, context switching (demonstration), states of a thread and so on. As an acknowledgement to the successful completion of this level, the player is provided points. Fig. 9 to Fig.13 describes the concept being learnt. Fig. 14 describes the analogy used for describing starvation concept.

Level 3 – Capture Golden Eggs to Schedule: The major objective of any multiprogramming environment is to have some process running all the times that maximizes CPU utilization. This could be achieved by the operating system's major function called as scheduling. There are various types of scheduling, scheduling criteria and different scheduling a lgorithms need to be explained

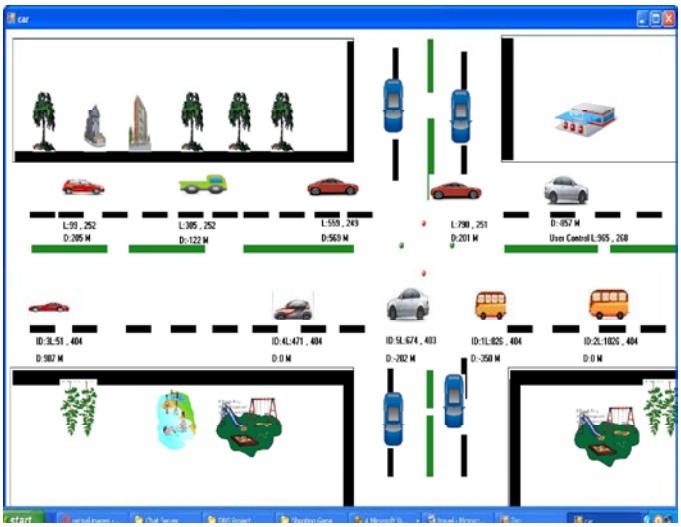

Fig. 13: Player car shifted after filling fuel

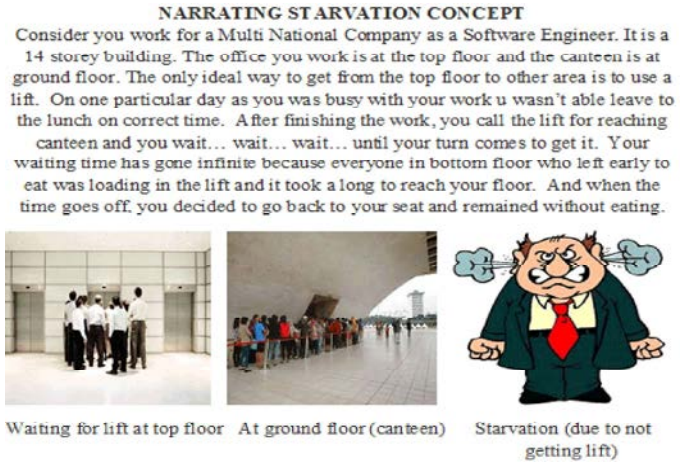

Fig. 14: Analogy describing starvation concept

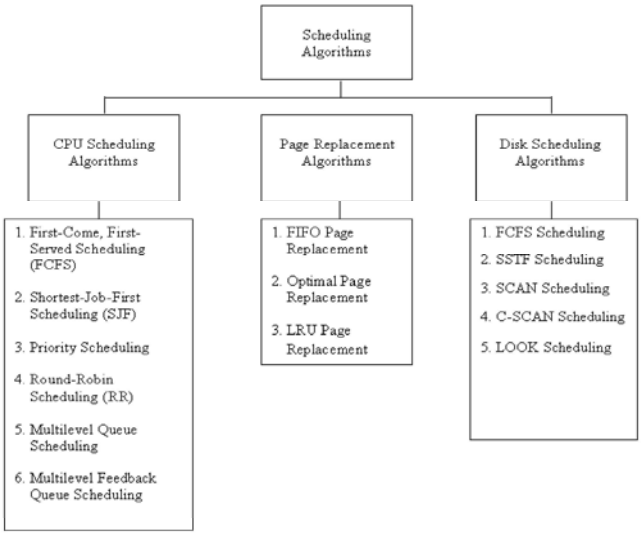

Fig. 15: Types of scheduling

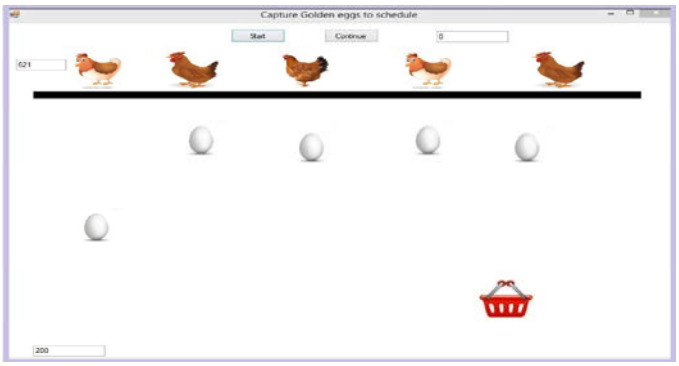

Fig. 16: Hens laying ordinary eggs

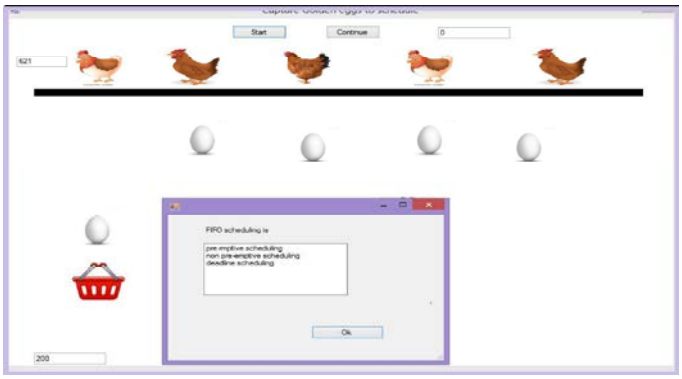

Fig. 17: Sample question displayed on capturing ordinary egg

Fig. 18: Hen laying golden egg

properly. The topics covered in this level are described in the Fig. 15. A practice problem section has also been given at the end for solving.

The objects used to explain scheduling concept is hen and eggs. There are five hens laying eggs. Those eggs can be an ordinary one or a silver egg or a golden egg. When the player clicks on silver eggs, the various scheduling algorithms descriptions are displayed. On clicking the ordinary eggs, the player will be posted with objective type questions to be answered. On clicking the silver eggs, conceptual questions are posted. On clicking the golden eggs, the problematic questions with multiple options are displayed. The player needs to solve the problems and produce the answers. The hints for the problems are also provided. The player has to solve the problems and the answer has to be entered in the answer text box. In case of right answer the player will be able to capture the next golden egg. Likewise the player has to capture a minimum of five golden eggs and solve at least five problems in order to move on to the next level. In this level also the questions are randomized. Fig. 16 to Fig. 18 depicts this implementation.

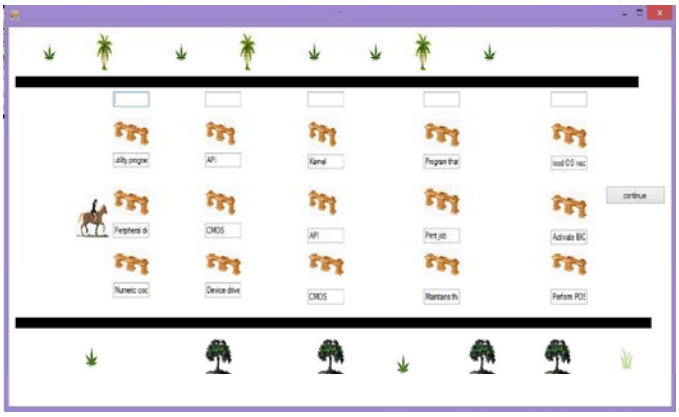

Fig. 19: Player enjoying horse ride along with obstacles

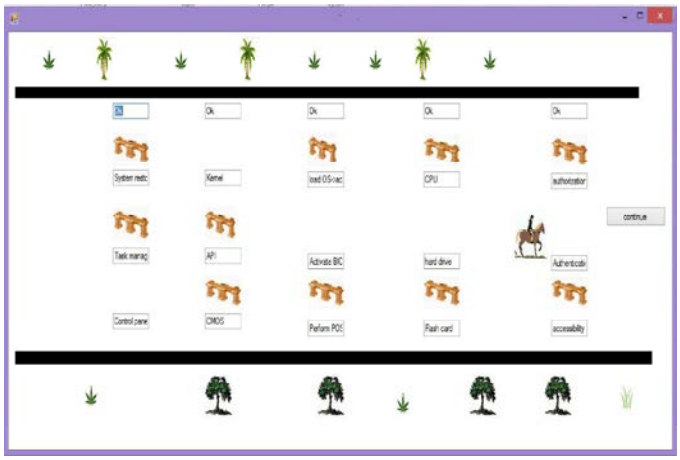

Fig. 20: Player reaching destination after clearing the obstacles by producing correct answer to the questions

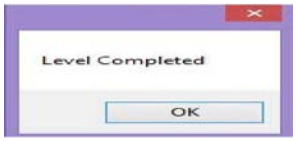

Fig. 21: Message displayed on successful completion of the current level

Level 4 –Match the Right Hint: Using the golden eggs collected in the third level, the player can buy a horse here at this level. The score must be sufficient enough to buy a horse; else the player must play level 3 again and earn many points. With the bought horse, the player can enjoy a horse ride by crossing various obstacles along the path. While riding, at any point of time an obstacle can arise at the path of travel. The obstacles on the path can be cleared only if the player produces the right answer for the prompted question. The question that arose here can be any questions that are related to the operating system course. There can be any number of obstacles in the path. Randomization has been done in this level. By the end of this level, the player would have learnt almost all the concepts related to the operating system subject. Fig. 19 to Fig. 21 describes the horse ride at this level.

Level 5 –Mastery Test (Test Yourself): Self assessment, aka mastery test is the final part in this gamification. This final level is designed in such a way where the player can evaluate himself / herself. This level aids the player to get to know their potential competency. The object used here is balloon and they are made to float in the air. All those floating balloons bear's questions with a timer set up for nearly 120 seconds. The player has to click on the balloon to reveal the questions and have to answer it. On providing the correct answer, the balloon gets burst; else it continues flying on air. For every correct answer, the player is awarded with points. If the player didn't get a satisfied score at the end of this level, he/she must redo the test until they get a valid score.

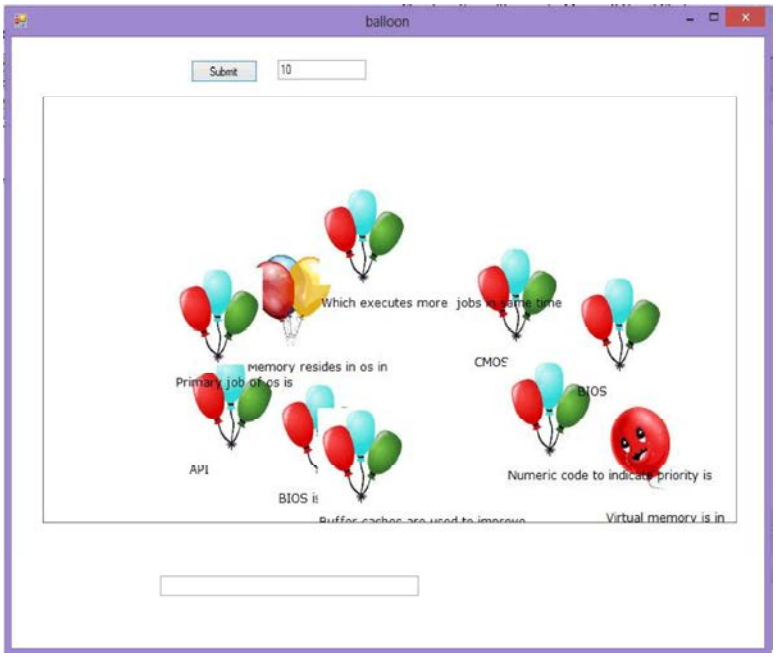

Fig. 22: Balloons flying in the air bearing questions

Fig. 23: Group A – Experimental Group

Fig. 24: Group B – Control Group

Being at this level, the player can go back to any of the previous other levels, can have some more practice and then can also try this level, in case if he/she is not able to get the target score. Bonus points are awarded on successful completion of this level within a single attempt. The mastery test scores and individual level scores are kept on updated in the database against the corresponding player. These scores can be used to analyse the knowledge level gained by the participants. Fig. 22 shows the balloons flying in the air bearing questions.

Experimental Analysis and result: The experimental analysis was made to identify the outcome of the system that is developed and deployed. All the learner participants were trained with the same target goal for the experiment. To study the game effects, a controlled experiment was carried out. Students from two sections of same semester Computer Science and Engineering participated in the experiment. Both sections were taught by the same teacher, all the student learner's followed the same textbook and carried out the same assessments.

The experiment used a balanced design where the 140 (70 per section) participants were divided into two groups with equal number of learners. It was also ensured that both the groups were divided involving equal mixture of slow learners, average learners and above average learners. The groups were named as Group A (Experimental Group) and Group B (Control Group) for identification purpose (Fig. 23 and Fig. 24). Experimental group followed traditional approach (classroom lecture) and gamified approach (e-learning) whereas; the control group followed the traditional approach which was done on a constant basis for 12 weeks (one semester of class works).

Table 8: Weekly activities carried out and recorded outcomes

Week (s)	Activities Carried Out	Recorded Outcomes
Week 1	Course Introduction to the student learners Provided hands-on training in making them to get used to the course stuff that includes the e-learning platform introduction, gamification rules, expected and quantifiable outcomes and, player effort to be made. Collected the basic information about the students by asking them to complete their personal profile and getting them registered with username and password individually to record their score sheets.	/Active participation of the learners /Successfully undergone training and got introduced with the new learning system /Successful registration of the individuals in the e-learning platform
Week 2	Started with Level 1 of the Game – Shoot to learn	/Learning community got good spotlight on the basics concepts of operating system /Successfully cleared the first level /It was found that some slow learners made quiet few attempts by replaying the level to get cleared /These score sheets were viewed by the teacher at the end of week 2 to know about the performance of the individuals
Week 3 and Week 4	Started with Level 2 – Find the situation	/ Acquired clear understanding on the various important concepts in operating system / Successfully cleared second level
Week 5 to Week 7	Started with Level 3 – Capture Gold Eggs to Schedule	/Acquired good exposure and analytical knowledge on the various scheduling algorithms in operating system with a good problem solving ability /Successfully cleared the third level
Week 8 and Week 9	Started with Level 4 – Match the Right Hint	/ Acquired knowledge and analyzing ability on the various other operating system concepts / Successfully cleared the fourth level
Week 10 and Week 11	Started with Level 5 – Mastery Test	/Basic understandings in initial level helped the participants to clear this level with ease
Week 12	Final Assessment	/Obtained deeper understanding and sound knowledge in the overall course

During the 12 weeks of the course, the experimental students were made to take each level as per the prepared schedule in addition to the traditional teaching. These score sheets were viewed by the teacher at the end of every week to know about the performance of the individuals. The score sheets is a marker for the teacher that gives the progress of the individual's and at some point of time, it acts as an indicator to know about the depth of knowledge gained by the students. Attention was paid to individuals, to take constant participation in the gamified approach and complete the entire course without any dropping out in-between. The table 8 shows the weekly activities carried out and the outcomes that were recorded.

At the end of the 12 weeks, after making comparative analysis between the two groups, it was found that, the students in experimental group were three times efficient in mastering the course to a greater extent while comparing with the control group.

CONCLUSION

Gamification is giving positive results especially in the field of education. However, not all evident are successful. It means, while using gamification approach, one has to keep in mind the main goal of the course and not rely on including the fun factor to a greater extent. The primary intention of this proposed work is to make educational strategy an interesting one that provides intrinsic motivation and also paves way for the teachers to gain the students' attention. This is done by injecting enjoyment into e-education content which might make the learning community getting instantiating with curiosity and creative thinking. We are sure, that this attempt might bring learners' engagement and their retention in the course they have taken. There is no loser in this game, ever one are winner in the way they have got exposed to new concepts and techniques which they don't know before head. In future, the proposed approach can be

socialized, where peer communication can also be put in to effect, which could dissolve the isolation of the learner from the society, immediate availability of peers or teachers to clear doubts instantly and also might saves from getting addicted to the game environment.

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