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A New Learning Theory-based Framework for Combining Flow State with Game Elements to Promote Engagement and Learning in Serious Games

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Abstract: Serious games (SGs) are seen as a clear aid and a potential technique for motivating learners to engage in active and beneficial learning. The creation of SGs is a difficult task. Learning theory, learning aspects (pedagogy and learning materials), and game design are three cross-disciplinary issues related to successful SG design. Numerous studies have looked at this matter and provided guidelines and frameworks for resolving important research concerns. We discovered, however, that research hardly ever discusses the roots of learning theory in SGs. Unfortunately, designing proper SGs is still more of an art than a science. The science of SGs has to be developed on a strong theoretical basis. By illustrating how SGs may be understood from several theoretical viewpoints in learning theory and going through a number of core game design elements that are necessary for successful learning, this paper makes an attempt to solve this issue. Then, in order to encourage engagement and learning in SG contexts, we provide a new framework for the design and development of SG models that makes it easier to combine flow state with such game elements. The agile software process model serves as the basis for the development process in our system. The Unified Modeling Language was used to model prototypes and diagrams. A case study entitled "One day without the use of computer-based intervention technologies" was used to demonstrate the effectiveness of the proposed framework.

Keywords: Serious games, Flow state, GameFlow, Educational technology, Game elements, Digital natives.

1 Introduction

Computer gaming has a big impact on how we socialize and use our free time. The benefits of playing video games were discussed in [1, 2, 3] in terms of their cognitive, motivational, emotional, and social aspects. Serious or educational games are distinguished from games that are only played for enjoyment [4, 5]. This study emphasizes the need to combine game design with learning theories in order to produce educational games that are both enjoyable and engaging. In attempting to develop a novel paradigm that encourages engagement and learning in SG contexts, it analyses the interaction between flow state, SG design, and learning theories. Our hypothesis is supported by a case study created with the use of our framework and entitled "One day without the use of computer-based intervention technologies." The intended audience for this serious game is digital natives, who have grown up as enthusiastic technology users and spend a lot of time playing computer games.

The remainder of the paper is given as follows: The goals of this paper are stated in Section 2, along with the research questions that were encountered. Section 3 provides some issues with the theoretical basis of learning in SGs. In Section 4, various frameworks for designing SGs are reviewed. Section 5 summarizes the basic terminology and notions that will be used throughout this paper. Section 6 presents the methodology used. Section 7 provides an evaluation and comparison of several current frameworks based on various criteria. Section 8 concludes the paper.

2 Research Questions and Objectives

The development of successful SGs is challenging because of the trade-off between educational effectiveness and entertainment. Furthermore, the relationship between learning theory and SG is unclear. The authors in [7] stated that very little research has applied learning theory to SGs. According to the meta-analysis described in [7], only 91 studies were based on learning theory, while 567 studies did not use it as the basis of the analysis. The intricacy of the numerous disciplines and components necessary for successful SGs development is depicted in Fig. 1.

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Fig. 1: SGs design and development challenges

Numerous studies have examined this challenge and highlighted some guidelines and frameworks to answer related key research queries [8]–[14]. This paper focuses on the following issues in particular: 1) how can we make learning more interesting? 2) Which pedagogical techniques ought to be applied to assist learning objectives and tasks? 3) What are the requirements for effective instructional design for SG learning? This paper's main goal is broken down into two sections. It begins by examining what characteristics would entice learners to play games and keep them engaged in order to attain the desired learning outcomes, in an effort to provide answers to the questions raised above. In response to the first inquiry, we examined the various game elements and attributes that are applied to improve educational settings. For the second inquiry, we used a participatory design approach. For the third one, an extension of the gaming model known as Input-Process-Outcome, defined by [15], is proposed. Finally, to assess the effectiveness of the proposed framework, a case study entitled "One day without the use of computer-based intervention technologies" was developed. The effects of using computer-mediated technologies in the lives of digital natives are covered in this game. Additionally, we performed usability testing to look into the learners' acceptance of the proposed game.

3 Learning-theory Foundations in SGs

Serious games (SGs) are a form of education and entertainment that is designed to educate as well as amuse. Unlike games that are just played for fun, games intended for learning are labeled "serious" [4], [5]. According to [16], SGs encompass pedagogy as well as stories, art, and technology. SGs are mostly developed based on learning theories. The four major learning theories are behaviorism, cognitivism, humanism, and constructivism, which include 16 learning principles [7]. Table 1 illustrates the classification and characteristics of the four learning theories and their representative principles [7].

Table 1: Classification and Characteristics of Learning Theories and Their Learning Principles

Learning Theories	Learning Principles	Characteristics
Behaviourism	Direct instruction	Feedback, prior knowledge, specific teaching goal, distributed practice.
	Programmed instruction	Sequence material, individualized instruction, feedback, initial behaviour, terminal behaviour, self-learning.
	Social learning theory	Social learning, modeling, observation, imitation, self-regulation
Cognitivism	Attribution theory	Self-ascription, external attribution, internal attribution, self-attribution, motivation, reward or punishment.
	Elaboration theory	Simple to complex, learner centred, analogies, elaboration.
	Cognitive development	Cognitive development, schema, assimilation, accommodation, dis-equilibration, equilibration, sensorimotor period, preoperational period, concrete operational period, formal operational period.
	Conditions of learning	Conditions of learning, transfer of learning, instructional event, diversity, reinforcement.
Humanism	Experiential learning	Experiential learning, learning cycles, learning style, concrete experience, reflective observation, abstract conceptualization, active experimentation, diverger, assimilator, converger, accommodator.
	Social development theory	Social culture, social development, zone of proximal development, scaffolding.

Constructivism	Case-based learning	Student-centred learning, critical thinking, problem solving.
	Cognitive apprenticeship	Learning by doing, cognitive apprenticeship, authentic practices, exploration, active learning, and active thinking.
	Discovery learning	Inquiry-based instruction, prior knowledge, discovery learning, trial and error.
	Problem-based learning	Problem-based, authentic (real world), problem solving, teacher as facilitator, learner centered.
	Situated learning	Authentic activity, learning situation, situated learning, apprenticeship, legitimate peripheral participation, meaningful learning, socially shared, distributed.
	Activity theory	Activity system, action, dynamic relations, mediated, structure, subject, objective.
	Actor–network theory	Actor–network, actors can be human or non-human.

Knowing games' potential as a teaching tool requires understanding how they fit with various learning paradigms. According to constructivism theory, people actively construct their knowledge via experience and learning. The premises of reinforcement and learning by changing behaviour are fundamental concepts in the behaviourism philosophy. The importance of memory and past knowledge in learning is covered by the cognitivism theory. The notion of humanism addresses issues of self-determination. Out of 658 researches, 12 were defined as being based on behaviourism, 17 as cognitivism, 25 as humanism, and 48 as constructivism, while 567 were characterized as not using a learning-theory foundation, according to [7]. Our strategy involves incorporating constructivism, behaviourism, and humanism into the construction of our SG framework. Other than learning theories, the following elements [17], [18] should be considered while creating a game design: 1) the cost-effectiveness of the game; 2) the game's assessment techniques; and 3) the game's educational value. SGs must also be effectively designed and built. Adaptive challenges, control, continual feedback, interactive problem solving, specified goals and regulations, and sensory inputs are some of the fundamental components of well-designed games [19]. The components of an effective video game, according to [20], are interaction, motivating qualities, narrative context, distinct objectives, and rules. Effective and well-designed vary in that the former takes into account the key components needed to build SGs, whilst the latter refers to the aspects utilised in well-designed games to guarantee that the learning objectives are met.

4 Prior Research

Many scholars have created a variety of frameworks based on diverse viewpoints based on the many characteristics and ideas of SGs to identify the elements of serious gaming. For instance, design features based on experience learning were suggested by the authors of [21]. Other frameworks include the learning process described in learning theories such as active learning [15], [22], experiential learning [23], and flow theory [24]. The final framework represents the transition from a learning-centric to a development-centric viewpoint [25]. Some of these frameworks and others are briefly explained as follows:

1) Macro design concept (MDC) [14]: This structure provides macro-design principles that clarify eleven essential game-design elements to aid in the creation of SGs.

2) Input-Process-Outcome game model [15]: This framework is based on active learning theory. The aim of the "input" part is to design an instructional program that incorporates the game's characteristics. The game cycle is presented in the "process" part. The achievement of the learning objectives is demonstrated in the "outcome" part.

3) Person-Artifact-Task (PAT) model [24]: This framework is based on flow theory in a computer-mediated environment. Person, artifact, and task were the three separate but interconnected elements that the model addressed.

4) Educational Game Design Model ((EGDM)) [25]: This framework combines learning elements (pedagogy and learning contents) with game design. The authors have emphasized on the usability that comprises efficiency, competence, and satisfaction in both the game design and learning content of the game.

5) Four-dimensional framework (FDF) [26]: This framework states the relationship among the following four dimensions: (1) context (user engagement and user learning), (2) learner specifics (user learning and user behavior), (3) pedagogy (user behaviors and player feedback), and (4) representation (player feedback and user engagement).

6) The cognitive theory of multimedia learning [27]: This framework addresses the pedagogical dimension of the cognitive theory of multimedia learning to facilitate learning in educational games.

5 Some Theoretical Foundations for SGs

5.1. Flow State and GameFlow

To feel the fun, users have to be in a flow state. The flow theory [28] is widely accepted as one of the fundamental models for improving the game experience. When an individual experiences flow, they are said to be in a "flow state." For flow to take place, eight factors must be satisfied [29] (refers to Fig. 2): (1) clear task goals; (2) unambiguous feedback; (3) skill-challenge balance; (4) control; (5) concentration; (6) action-awareness merging; (7) self-consciousness loss; and (8) time transformation.

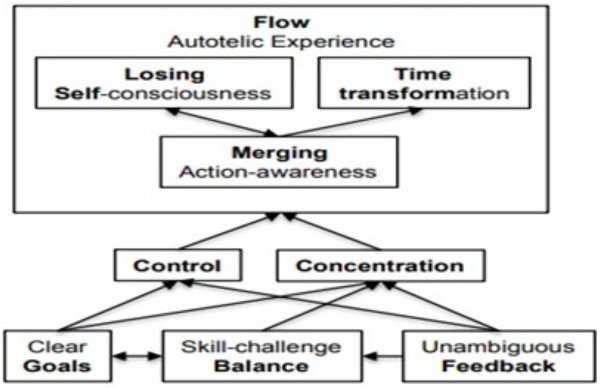


Fig. 2: An illustration of flow dimensions

To identify the essential components of player satisfaction in video games, Sweetser and Wyeth [30] undertook an extensive assessment of the literature on usability and user experience in games. The outcome was the GameFlow paradigm, which has eight fundamental components: focus, difficulty, mastery, control, clarity of objectives, feedback, immersion, and social interaction. These components closely complement the flow components (see Table 2).

Table 2: Mapping of the GameFlow model from game literature to the elements of flow

Games literature	Flow
The Game	A task that can be accomplished.
Clear goals	The task has clear goals. Goals are clear when participants know what they are supposed to do. Clear goals increase the concentration.
Concentration	Focusing on the task at hand
Feedback	The player must receive feedback on their progress towards completing the task.
Challenges	Perceived skills should match challenges. Games should be sufficiently challenging and match the player's skill level (Challenge-Skill balance)
Player Skills	Games must support player skill development and mastery.
Immersion	Deep but effortless involvement (action-awareness merging), reduced concern of self (losing self-consciousness) and losing sense of time (time transformation). When user is totally engaged with the activity they stop worrying about self-evaluation and others opinions. During the deep involvement participant lose the sense of time. This happens because user is fully absorbed with the activity.
Control	Allowed to exercise a sense of control over actions

5.2. Game elements and attributes

The parts that make up a game and give learners an engaging experience are known as game elements. Every game element must have attributes that may be utilized to affect how they are used when developing SGs. For instance, a game's world can be 2D or 3D, and learning materials should be presented progressively and in a logical order. Rewards can also be used to encourage learning. Scholars indicate that the use of game components can help learners become more engaged in the material being taught. For instance, Hamari et al. [31] consider game elements as intrinsic and extrinsic factors that increase a learner's motivation. Twenty-five successful game elements that are divided into three levels by Werbach et al. [32] and that have a positive association with learners' involvement include: 1) components — lower level elements (levels, points, achievements, avatars, badges, combat, leaderboards, teams, etc.); 2) mechanics — rules that employ lower level elements (challenges, chance, competition, collaboration, feedback, resources, rewards, and so on); and 3) dynamics — ideas that influence the game (constraints, emotions, narrative, and so on). Twenty-five

game components from the literature were also identified and categorized into four dimensions by the authors in [26]. For the purpose of our study, Table 3 lists brief descriptions of the relevant game elements.

Table 3: Elements of Game Design for Learning

Element	Description
The gaming Environment	It is an imaginary place where players go during playing the game.
Challenges	Challenges are game tasks or exercises that require an effort to perform.
Rewards	Reward is game element that satisfies the user and motivates them to achieve more. Benefits granted after a certain action. Games can provide extrinsic reward like points and intrinsic reward where tasks are rewarding by their nature.
Levels	Steps defined in the progression of a player.
Game Mechanics	Refers to the set of activities repeated by the learner throughout the game.
Feedback	Information about how the player is performing. It can be provided with the help of visual and audio elements.
Flow state	To feel the fun users have to be in the channel of flow state.
Visual Aesthetics	Include visual elements such as the overall look and feel of the game. It determines how tools and functions of the game mechanics are visualized and how feedback is displayed.
Game Fantasy	Refers to the environmental contexts that provide virtual world imagery.
Sensation	Multimedia presentation of the virtual world.
Narrative	Describe what occurs in the virtual world. It includes setting, character and action.

6 Methodology and System Workflow

6.1. Methodology

According to contemporary conceptions of effective learning, learning is most successful when it is proactive, reactive, social, experiential, problem-based, and offers quick feedback [7], [33]. SGs have the potential to offer learning experiences with those features, but pedagogical aspects are often not taken into consideration when designing SGs. For the successful deployment of SGs, appropriate design approaches and guidelines are also required. Some guidelines and frameworks that designers and educators need to take into consideration when creating SGs are emphasised in [8]-[14]. They reported that interactivity, engagement, pedagogy, the target, motivation, game elements, game attributes, debriefing and evaluation, increasing complexity of challenges, the possibility of game assessment, etc. are fundamental factors for successful SG design. By taking these guidelines into account, our methodology is based on a basic ontology that maps game elements and learning attributes in a coherent way, taking into account both game design and the learning process. In terms of learning, a qualified instructional computer game should include the following items: learner characteristics and needs; learning content and objectives; learning strategy (gameplay); feedback; and motivating learners by designing meaningful experiences that should motivate them to learn more and keep the new knowledge for long-term learning. To embed fun with learning and according to the study of the four types of learning theories, game characteristics such as flow state, game elements, game attributes, game narratives, game play, and game mechanics (i.e., the aesthetics and the mechanisms to reach the state of flow) must be considered. Fig. 3 generally presents our methodology workflow, which contains different main phases in an iterative manner.

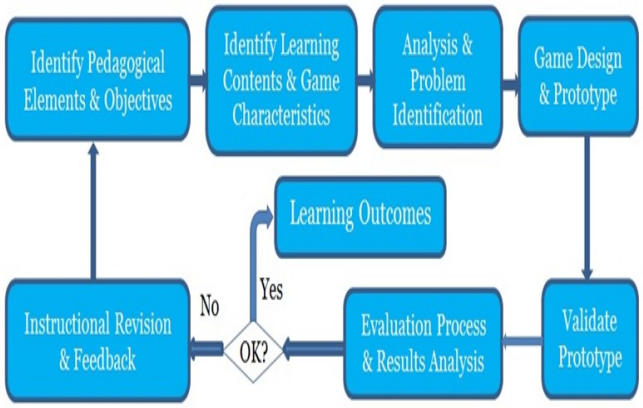


Fig. 3: Methodology Workflow

The initial step of the framework is to define the pedagogical elements of the SGs that will be developed, including: the learning objectives of the educator; creating learner interactions using a use case diagram; understanding the learner's characteristics and needs; etc. According to [34], developing SGs requires the involvement of people from education and game development. Therefore, communication between both parties is essential to ensuring a successful SG design. Consequently, it is important to combine experts from both game design and learning content in the design activities. The participatory design method or a comparable user- centered design (UCD) approach [35]-[37] is typically used as a pedagogical element to achieve this goal. Participatory design is defined as a philosophy that places the learners at the centre of the design process, taking into account their characteristics, needs, skills, desires, knowledge, etc. When these elements are agreed upon and determined, the learning content and game mechanics are created to reach a state of flow. Game characteristics include the aesthetics and the mechanism to achieve the learning outcome, such as game fantasy, challenge, rules or goals, visual aesthetics, feedback, etc. Once the game is designed, the evaluation process is performed in order to determine whether the game prototype is accepted or not. The feedback phase involves revising instructions and going back to any related parts that may not achieve the intended learning outcomes. This process will be repeated until all goals and objectives have been learned. This process will be done iteratively until all goals and objectives are met. For rapid testing and iterative design, we follow the agile software development model [38] as a framework for the development process (see Fig. 4). One of the main principles of agile development is active communication between stakeholders. In agile development processes, the system is tested by users from the beginning using rapid development and feedback loops.

Fig. 4: The agile process model

6.2 Gaming Model

To build and create successful SGs, pedagogy (learning) and game design must be taken into account (fun). Learners must be in a flow state to ensure fun, and this necessitates that the learning activities offer quick and precise feedback. It is required to develop a model of instructional gaming and learning with the aim of integrating games with learning theory in order to support flow states [7]. When a number of conditions are satisfied, an optimal experience known as a "flow state" occurs; this is characterized by high levels of concentration, engagement, motivation, and immersion. Engagement in educational games may be increased by implementing elements such as amusement, sociability, identification, difficulties, distinct goals, rules, and feedback. The research community is becoming increasingly interested in issues of motivation and enjoyment. The Input-Process-Outcome (IPO) models based on activity theory [15], the ARCS-V motivation model [39], and frameworks of flow and motivation [30] are three more comprehensive models of gaming motivation. After studying these models, we propose an extension called the Inputs-Process-Evaluation-Outcomes-Feedback (IPEOF) model of flow and motivation, as shown in Fig. 5. The ARCS-V model (an acronym for Attention strategies (interest), Relevance strategies (goal), Confidence strategies (challenge), Satisfaction strategies (feedback), and volition) contains a synthesis of motivational and volitional concepts and theories that provide a foundation for a motivational design process. In [15], achievement of the learning objectives is the only learning outcome as a result of the gaming experience. Despite the phenomenal achievements, many people are still unsatisfied because, after each performance, they are looking for something new. So in our model, there are two types of outcomes: achievement and motivation. Generally, when our motivational needs are fulfilled, we rejoice. The new model introduces an activity system as a framework that assists the game development team in designing successful learning games. It uses analysis, design, development, implementation, and evaluation parameters to support learning outcomes and activities.

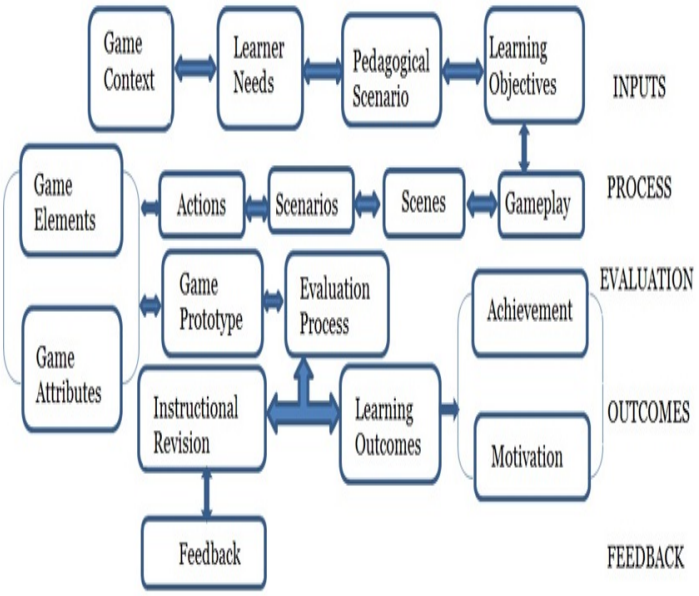


Fig. 5: Inputs-Process-Evaluation-Outcomes-Feedback (IPEOF) Gaming Model

6.3. System Modeling

System modeling is presented using Unified Modeling Language (UML) graphical notation applied by [40]. UML is a standard language for modeling the design of object-oriented software systems. There are several UML tools, the majority of which concentrate on providing assistance for creating UML diagrams and producing code from them. Table 4 demonstrates the correspondence between UML diagrams and the educational game elements to be modeled.

Table 4: Correspondence between educational game elements and UML diagrams

Educational Game elements	UML diagrams
Main game structure	Class diagram
The interaction between actors and the system	Use case diagram
Game acts	Package diagram and state diagram
Scene in each act	Package diagram and state diagram
Actions within a scene	Activity diagram
Scenarios in an act	Package diagram and state diagram
The transition from one act to another, scene changes and scenario changes	State diagram
Game challenges	Sequence diagram

6.4. Applying the Framework

We created the SG "One day without the use of computer-based intervention technologies" to evaluate the methodology that were provided. This game was developed to educate the digital natives about the overuse of computer-mediated technologies in their daily social life. The proposed game aims to convey the idea that "Moderation is the best choice" to both teachers and parents who want their children to enjoy technology without experiencing any drawbacks. The development of a plot, storyline, and game environment to accompany the game was the first stage in creating such a game after choosing the subject to be covered. The gaming environment consists of a variety of things (such as doors, windows, etc.) and a few things happening, like the doors being open. Both game design and learning attributes were taken into consideration when we made the decision to create our game. For instance, the learning materials are organized and provided in a sequential manner. For active learning, learning environment should be authentic with authentic tasks. Learning in the real world is authentic learning. Authenticity has been shown to be an effective component of meaningful learning. Additionally, the "mood monitor" feature in the gaming environment offers feedback to let the player know how well they are learning. Furthermore, the game's plot has been carefully thought out and studied in order to create an appealing and engaging virtual environment with intriguing individuals that are necessary to achieve the game's ultimate objectives. By using storytelling techniques including narrative, plot, and story, the game helps players picture their goals. The story is composed of two characters (refers to Fig. 6).

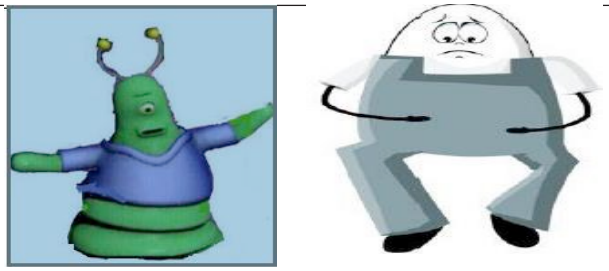


Fig. 6: The game's two major characters

The start-up user interface of the game included an animated dancing alien in a cosmos with planets and sounds to capture learners' interest (refers to Fig. 7). Fig. 8 presents the game's storyboard. A storyboard is a graphic depiction of the game's overall scenario. Prior to making the animation, it is used to demonstrate the action. The importance of the storyboard resides more in how well it defines the scope than in how well it is artistically done.

Fig. 7: A screenshot of an animated dancing alien in the universe as a game start-up

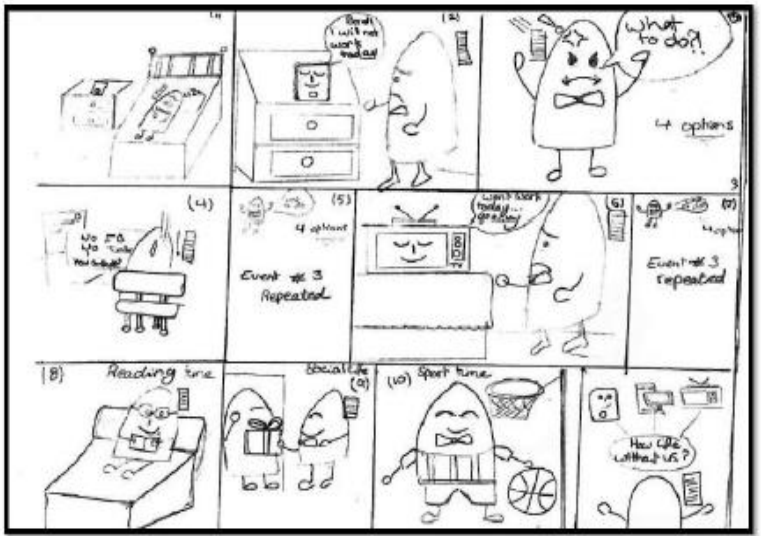
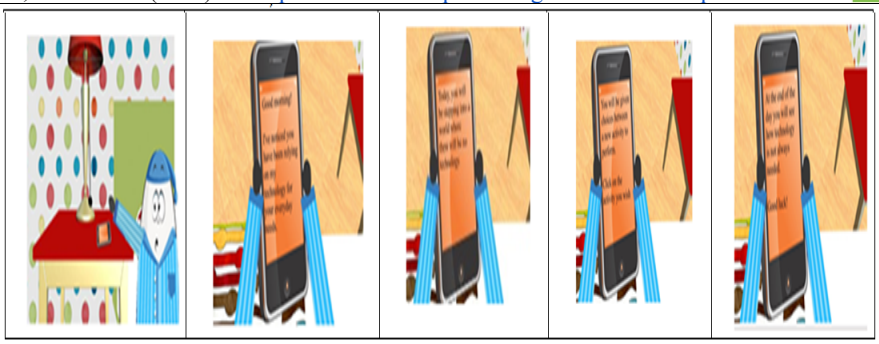
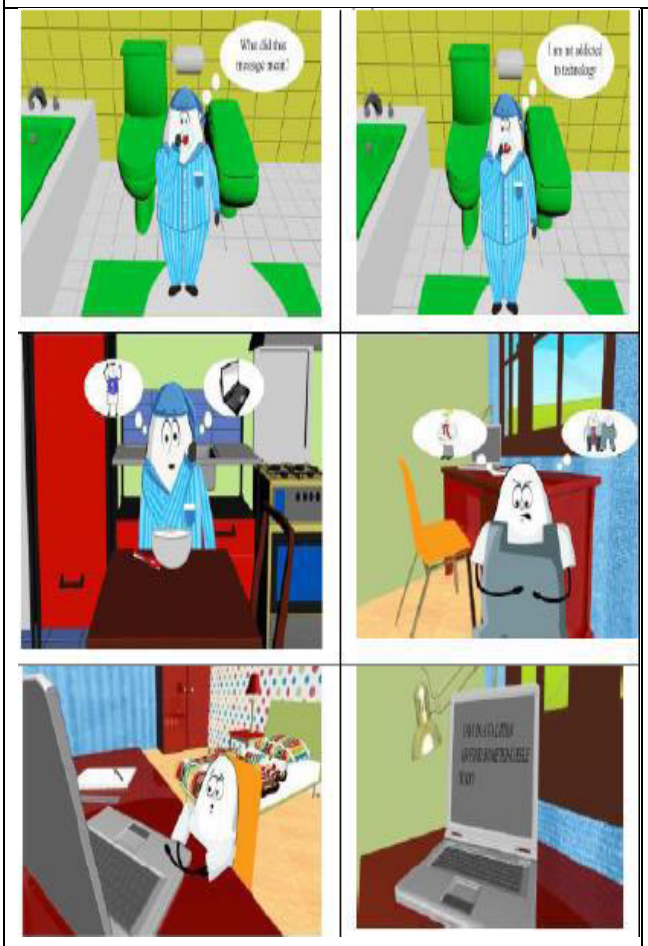


Fig. 8: Game storyboard

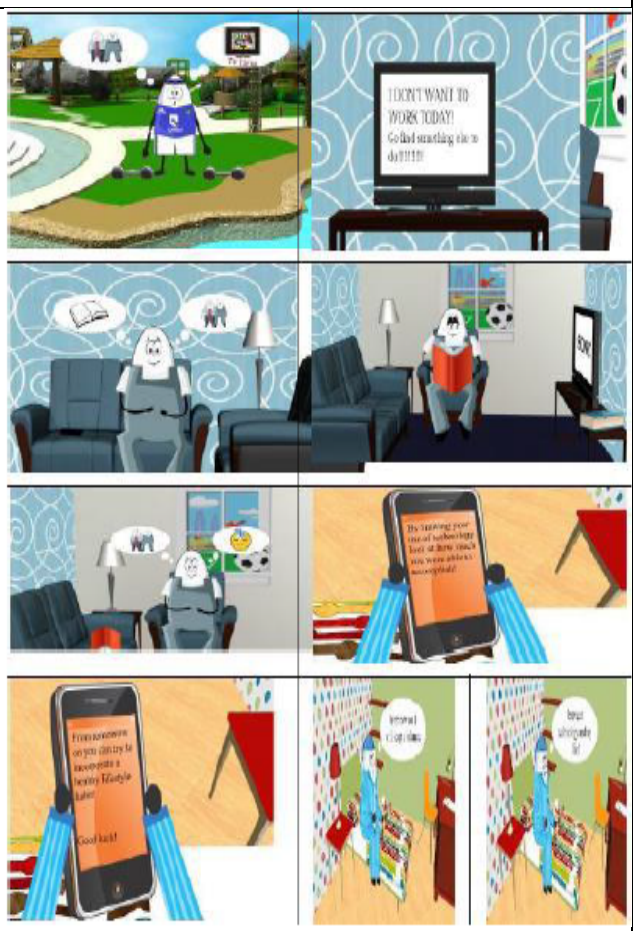
The plot of the narrative is introduced when an animated character awakens to a message on his mobile device. The message implies that the character has grown reliant on technology and that, as part of the assignment, they must go an entire day without using it. He wonders what the message signifies as he gets up and gets ready for the day. The player or learner may choose and determine what the character should do in a variety of scenarios that are provided. One of the scenarios will involve technology (e.g., viewing TV) or physical activity (working out, visiting neighbours, etc.). These choices will direct the character to various locations inside the home, enabling him to complete his tasks. If the player or learner selected a technology-related assignment, it would be swapped out with another technology-related one. Each scenario will indicate if the character is able to employ the technology or not. The duration of the task and its need both play a role in this assessment. The character's task will be to provide him with a "mood monitor." Depending on the specific work, the mood monitor will show the character's current state of mind (for example, frustration when he is unable to play PlayStation or joy when he finishes his responsibilities). The narrative describes many learning situations with various collections of things and events at various levels. Screenshots of the game environment at various game levels (basic, intermediate, and advanced) are shown in Fig. 9 (a–c).



(a) Screenshots of the game's world at its initial level



(b) images of the game's world at the intermediate level, showing several scenarios



(c) images of the game's world at the advanced level, showing several scenarios

Fig. 9: Screenshots of the game's environment at various levels (a) initial, (b) intermediate, and (c) advanced

7 Experimental Results

The entertainment value, educational potential, and utility of computer games are directly tied to their quality rather than how well you play them. Players won't play a game if they don't love it. Our proposed SGs have been assessed for player satisfaction using the GameFlow criteria (on a scale between one and five, indicating the extent to which the game supports that criterion, see Table 5). These results were used to provide overall values for each GameFlow aspect as well as an overall rating for the complete SGs. The scores from one to five denoted "not at all," "below average," "average," "above average," and "best (well done)." Survey techniques are frequently used in studies of child computer interaction (CCI) to get data on usability. We employed one of the Fun Toolkit techniques [42] such as the

Smileyometer rating scale, to gauge how satisfied the learners were. The Smileyometer rating scale is a visual analogue scale that is easy to complete by circling one face for each question and requires no writing on the participants' part (see Fig. 10). The five major categories that have been covered in Section 3 are: 1) Developing game design; 2) Well-designed games; 3) Effective video games; 4) Four major learning theories; and 5) Key elements of a game. Table 6 compares and analyses our proposed gaming model, known as (IPEOF), with some other existing frameworks and models based on these five major categories.

Table 5: Assessment of player enjoyment in the proposed SGs using GameFlow criteria

Element	Criteria	Scale	Description
Clear Goals	▪ Overriding goals should be clear and presented early. ▪ Intermediate goals should be clear and presented at appropriate times.	5 5	o Overriding goals are clearly presented in the game's introduction. The game's introduction provides an in-depth, intriguing background story where the idea gets started when an animated character wakes up to a message on his phone. The message implies that the protagonist has grown reliant on technology and that his task will be to go an entire day without utilizing it. o Intermediate goals are clearly presented via different learning scenarios: technology-related (e.g. watching TV, etc.), or physical-related (e.g. exercising, visiting his neighbors, etc.). The many game-based scenarios were developed using the idea of situated authentic learning and real-world problems.
✓	Overall values	**5**	
Feedback	▪ learners should receive feedback on their progress to their goals. ▪ learners should receive immediate feedback on their actions. ▪ learners should always know their status or score	5 5 5	o The game provides continuous feedback to learners on their goals, actions and status. o The "mood monitor" function in the gaming environment provides feedback to help the player know how well they are learning. o Learners are immediately notified when goals are completed and can check the status of their goals, sub-goals and completed goal.
✓	Overall values	**5**	o Every action the learner performs, and the progress of every task has feedback, usually in multiple forms (e.g. visual elements, animations, text based and audio messages that are related to the gameplay or game narrative).
Concentration	▪ games should provide a lot of stimuli from different sources. ▪ games must provide stimuli that are worth attending to ▪ games should quickly grab the player's attention and maintain their focus throughout the game. ▪ the player shouldn't be burdened with tasks that don't feel important. ▪ games should have a high workload, while still being appropriate for the player's perceptual, cognitive and memory limits ▪ players should not be distracted from tasks that	5 5 5 5 5 5	o Clear goals and feedback support concentration. Concentration is one of the flows outcomes. o The game is visually appealing with interesting character models and a detailed and attractive game/story world. o The game's introduction is visually attractive and provides an in-depth, intriguing background story through artistic works called story worlds via its both dramatic components and principles. o To attract the player's attention, we embedded a smart user-friendly graphical user interface (GUI). o The workload is high because there are lots of things to monitor as well as many authentic tasks to perform (e.g. technology-related tasks, and physical-related tasks, etc.). o Learner is always focused on more important, or interesting tasks rather than unimportant ones. o Multi stimuli were provided in multiple forms (graphics, animation, audio, etc.) and every stimulus in the game has a purpose and fits into

	they want/need to concentrate on		the game. ○ The simplicity and design of the interface makes it easier for the learner to express what he/she wants to do.
✓	Overall values	**5**	
Challenge	▪ challenges in games must match the player's skill level. ▪ games should provide different levels of challenge for different players. ▪ the level of challenge should increase as the player progresses through the game and increases their skill level. ▪ games should provide new challenges at an appropriate pace	4 2 2 2	○ According to the gameplay or game narrative, challenge-skill balance is above average. ○ Challenge in games can be balanced with learner skills through difficulty levels. The difficulty levels in our case contain little variation with a limited learning/task activity, consequently the game's level of challenge is below average. ○ Since the gameplay is almost straightforward with little variation in the game's difficulty levels, thus challenge-player progress balance is below average, and the game is not well-paced.
✓	Overall values	**2.5**	
Player skills	▪ players should be able to start playing the game without reading the manual. ▪ learning the game should not be boring, it should be part of the fun. ▪ games should include online help, so the player doesn't need to exit the game. ▪ players should be taught to play the game through tutorials or initial levels that feel like playing the game. ▪ players should be rewarded appropriately for their effort and skill development	5 5 5 5 3	○ Game environment supports the player with a smart user-friendly graphical user interface (GUI) screens. Each screen supports level of details (LOD) rendering techniques, where players are able to start playing the game immediately. ○ The user interface was designed to be simple to use and navigate. It uses a WYSIWYG (What You See Is What You Get) interface which eliminates a lot of the complexities of game development [41] as well as preventing the player from making mistakes, which avoids frustration and increases the player's confidence. There is also an abundance of help in different forms that fit in with the storyline. ○ The game interface and mechanics are simple, easy to use and learn as there is plenty of help. ○ The game's introduction is visually attractive and provides an in-depth, intriguing background story.
✓	Overall values	**4.6**	○ Players are rewarded via game elements and attributes.
Immersion	▪ players should become less aware of their surroundings. ▪ players should become less self-aware and less worried about everyday life or self. ▪ players should feel emotionally involved in the game	5 5 5	○ Both games, and learning attributes are embedded in the game scenario to promote player's engagement, learning and motivational outcomes. ○ To get the player emotionally involved in the game, we deeply combined interactivity and narrative in the gameplay via two engines (story engine and character engine). Consequently, it gives a better shape to the story, makes the player feel like he or she is part of the story, provides better dramatic experiences, and supports the narrative relevance of the stories being narrated. The resulting feeling for the player is total immersion or absorption in the game, which causes them to lose awareness of everyday life, lose concern for themselves and
✓	Overall values	**5**	

			have an altered sense of time.
Control	▪ players should feel a sense of control over their character or units, and their movements, and interactions in the game world. ▪ players should feel a sense of control over the game interface and input devices. ▪ players should not be able to make errors that are detrimental to the game and should be supported in recovering from errors. ▪ Players should feel a sense of control and impact in the game world (like their actions matter and they are shaping the game world).	4 4 4 4	o The player has full control over several aspects of the game. For instance, the embedded character engine allows player to feel a sense of control over their character, and their actual movements and interactions. o Game interface is simple, and non-intrusive to provide easy access to the game. o Generally, it is not possible to make errors that are detrimental to the game. During the gameplay, player is provided with the means for error prevention and recovery through the use of guiding messages. o It is relatively possible for a player to feel a sense of control and impact onto the game world as the game includes a linear narrative structure that restricts the player's freedom in interacting. Consequently, there is a limited variation in play styles or strategies available to the player.
✓	Overall values	4.0	
❖	Overall rating	4.4	❖ An overall rating for the entire SGs

Table 6: Comparison between our proposed framework and other existing frameworks

Criteria		Sources/References						
Categories	Elements	Our Framework (IPEOF)	[15]	[24]	[25]	[26]	[14]	[27]
Developing Game Design	Cost-Effectiveness							
	Evaluation of Game	√	√	√		√	√	√
	Pedagogical Effectiveness	√		√	√	√		√
Well-Designed Game	Interactive Problem Solving	√	√	√	√		√	√
	Specific Goals/Rules	√		√	√	√	√	√
	Adaptive Challenges	√	√			√	√	√
	Control	√	√	√		√	√	√
	Ongoing Feedback	√	√	√			√	√
	Sensory Stimuli	√		√				
Effective Video Game	Interactivity	√			√		√	√
	Motivational Attributes	√			√	√		√
	Narrative Context	√					√	√
	Goals & Rules	√			√	√		
Learning Theories	Humanism	√	√	√	√			√
	Constructivism	√						
	Behaviorism	√	√	√		√		
	Cognitivism					√		√
Key Elements of Game	Rules	√				√	√	√
	Outcome	√	√	√	√	√		√
	Challenging goals	√			√	√	√	√
	Feedback	√	√	√	√	√	√	√
	Representation	√				√		
	Gameplay	√		√	√	√	√	√
	Pedagogy	√				√		√
	Goals & Objective	√		√	√	√	√	√

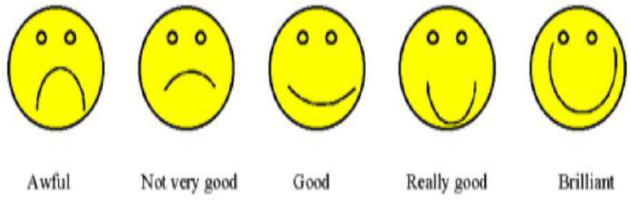


Fig. 10: A Smileyometer

8 Conclusion

Developing SGs is not an easy task. SGs are made up of three primary components, according to researchers and professionals working in the field: learning elements (pedagogy and learning content), game design, and learning theories. Each component requires the collaboration of multiple stakeholders and specialists with diverse backgrounds. Furthermore, the link between learning theories and SGs is currently sophisticated. This paper addressed this challenge from the perspective of learning theories and focused on the answers to the following research queries that were encountered in the education domain, namely: 1) how can we make learning more interesting? 2) Which pedagogical techniques ought to be applied to assist learning objectives and tasks? 3) What are the requirements for effective instructional design for SG learning? In response to the first question, we examine the many game elements and attributes that are utilized to improve educational settings. For the second inquiry, we used the participatory design approach. For the third, a new gaming model named (Inputs-Process-Evaluation-Outcomes-Feedback) was suggested. The GameFlow and Fun Toolkit have both been used to analyze the effectiveness and performance of the proposed framework. On the basis of five main criteria, comparisons with current frameworks and models were examined. We created the serious game "One day without the use of computer-based intervention technologies" to evaluate the technique that was carried out. This game was developed to educate the digital natives about the dangers of abusing digital technology in their regular social interactions.

Conflict of interest

The authors declare that there is no conflict regarding the publication of this paper.

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