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Review of Components from Frameworks and Models for DGBL for History Based Courses

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Abstract: Playing a game is an essential factor that leads towards human development and then learning. Usually, it can be seen that children can spend hours in playing different non computer based games like hide and seek, board games, such as chess, Ludo, checkers and keep them engaged in their plays. These games not only keep them busy but also improvise their creative thinking and learning ability. When children play, it can be witnessed that they also learn while play. In this way, play can be related to learning, enhancing children's cognitive and emotional development through social and cultural context. Digital Game Based Learning (DGBL) can also be useful as a supportive choice for traditional class lectures. The intent of DGBL is to incorporating new methods to existing instructional way and at also simultaneously, empower learners to gain skills and capabilities that may be beneficial in future endeavors. This paper explores the existing frameworks and models that are being used for the development of games for the classroom and identifies the 13 components that can be used for the development of history based games.

Keywords: learning, serious games, contents, classroom, children;

I. INTRODUCTION

Literature shows, that a lot of researchers and educationists are conducting research in different parts of the world to make the classroom learning effective and interactive. Classroom learning is a crucial part of the learning of our younger generation. As students gain basic knowledge of their courses in the classroom. With the inventions of ICT infrastructure, changes are being made with the time in the traditional classroom environment of using blackboards. From the overhead projectors to the multimedia projectors, and then smart boards and then games and specifically designed course-specific games. These moderations in the classroom environment have time to time proven effective in different scenarios.

Smeets' research shows that this perspective of ICT is often not widely used as teachers use ICT as a support tool instead of bringing change in classroom practice[1], [2]. Certainly, teachers' beliefs and attitudes, mainly to constructivism, are a major factor in the adoption of ICT in the classroom[1], [3]. The use of technological interventions for teaching and specifically learning, still has not transformed into a completely new form[4]. Incorporating new trends have always been a challenge, especially in academics, as it needs to involve all the students of that class on one platform. Digital Technologies does not only help in the personal grooming and development of students but also helps in the effective deliverance of curriculum in modern education[5]. These curriculum shifts require active learning like flipped classroom, team based activities and many forms[6]. In 21st century, ICT applications are being used in every field of life including academia[7]. The increased access of smartphone, tablets, laptops have increased the access to ICT infrastructures [8], but still, research is being conducted to explore the impacts of these technologies in classroom learning. Computer Games have now been one of the most preferred activities for teenagers[9]. Research conducted at Pew Research Center researchers[10] to identify the usage of computer games in 2007 in America, witnesses that in the ages of 12 to 17 years, 78% of teenagers engage themselves in computer games having gender division as 34% males and 18% female using computer games for two or more hours in a day. These games have an influential factor, as the players feel themselves as any player or character of the game and not only fantasizes but more and more involved in the game either in discussions or in their behaviors. [11].

Game Based Learning (GBL) refers to the use of games for the learning and educational purpose. Gaming has gone beyond the traditional boundaries, as the evolution of serious games can be witnessed by research and industry. DGBL is a kind of GBL that combine educational material with games[12], which can provide learners an opportunity to learn with fun and effectiveness. DGBL can also be useful as a supportive choice for traditional class lectures. These games can improve students' performance[13], [14], therefore, they are being used by teachers to support teaching and learning. Many studies show that learners with the approach of DGBL feel more relaxed and their anxiety levels also reduced [15]–[17]. Studies also show that students' interaction with learning

systems for improving their outcomes have been reported as the potential of computer games [18]–[21]

Therefore, many models and frameworks have been designed and implemented by the researchers in every field of life to incorporate the concepts of DGBL for education and learning. To design any such game, a frame/model is required that can work as a base for the development of a game. This paper presents the review of existing models and frameworks for the GBL to identify the components that can serve as a base to develop the DGBL environment for history based courses. Research shows that a few models or frameworks have been proposed that may be used for history based courses. Therefore, at the initial level, this paper tries to identify the components from the existing models that can be used to fill the research gap and provide the layout for the building of the framework/model.

II. METHOD FOR CONDUCTING REVIEW

In order to construct a game design model for History course, a literature search was performed to find research articles from different popular databases like IEEE, Springer, ACM, Sage, Google Scholar and ScienceDirect. Specific Boolean strings were used to search for the relevant frameworks and models. Search keywords used were like "Game based learning" or "game" or "digital game", "frameworks DGBL" or "serious games models" or "History games model". Selection criteria also included publication dates between 2000 and 2018, publication types like journals, proceedings and transactions.

Frameworks and models have been selected for further investigation that provided theoretical and pedagogical aspects to develop the proposed model. Also, the game components for the design of GBL were considered. Section III reviews the existing frameworks and section IV reviews the existing models for the games for learning and education.

III. EXISTING FRAMEWORK FOR GAME BASED LEARNING

This section describes the framework being used for the DGBL. The objective of this review was to find out:

1. the common components from different game design frameworks that are used for leaning
2. the relevance for the children or any user.
3. Either the type of framework is general purpose or specially designed for a particular domain

The search scheme used in this section to perform review is the same as described in section II. From the literature search, three frameworks have been selected for further investigations[22]–[24]. The search result also revealed a framework to design serious games for vocabulary learning of children with autism spectrum disorder (ASD). This framework [25]–[27] and its components [28] were excluded from the review as it was a specialized framework for ASD. A summary of these three frameworks is described in sections below.

A. DPE framework

[22] has mentioned that there is no such standardized practice and common language available for the design of a serious game, therefore, a model was proposed for the design of serious games by [22] having three components, which he named as design, play, and experience (DPE). DPE framework is an extension of the MDA framework i.e. mechanics, dynamics and aesthetics[29], which was proposed for the design of entertainment games. The components of the DPE framework revolve around design and gameplay. As the game is designed by the designer, considering the needs of the system whereas the users or player plays the game and gains experience by playing. There are four layers of the DPE framework design i.e. learning layer, storytelling layer, gameplay layer, and user experience layer. All four layers cover all three game components of DPE i.e. design, experience and play. The DPE framework along with its components is shown in Fig. 1. The function of each component in the four layers is discussed below.

Learning layer: This layer tells, that to teach the user while playing games, the contents and the pedagogy are designed by the designer. The design helps to gain experience and achieve the learning outcomes.

Storytelling layer: Storytelling occurs as a designer's story in the game. Therefore, there are two types of stories in each game, namely the story of the designer and the story of the user. The designer uses different tools like setting, character design and narratives to create storytelling. This layer in the game includes three things i.e. designer's story, interaction, and the choice that the user makes throughout the game. This layer ultimately gives the player's story as resultant.

Gameplay layer: This layer define what the player does in the game. This comes up as the rules and regulations defined for the game which includes what the user can do in the game and what challenges will the user face. Dynamics are the resulting situations that take place in the game when the user starts interacting with the game by applying the rules of the game. The resulting experiences and emotions gained by the user are referred to by the component effect.

User experience layer: This is the lowest layer in the framework and the most prominent layers for the player. The intention behind the development of the game is to give transparency to the user while the user interacting with the game environment. This given transparency may lead towards the increased learning experience as the user can focus on other layers (gameplay, storytelling and learning) rather than thinking of how to interact with the game.

B. Conceptual framework for Serious games

A framework proposed by [23] has been developed by integrating learning and pedagogy theory with game requirements. The purpose of this model is to achieve an effective learning experience for users through serious games by providing designers and practitioners with a conceptual

framework. This conceptual framework is based on the input-process-outcome (IPO) learning model by [30] which in the backend uses the technology acceptance model (TAM) for the validation. This framework like the IPO model also measures the user achievement in the game to measure the learning outcomes and to assess the learning of the user. This model also depicts the serious game design attributes to ensure by using the approach of game based learning. The conceptual framework for the serious game along with its components is shown in Fig. 2. Instructional content deals with the material or contents required as input to the game. Game attributes are the features won which game focuses. Learning outcomes are the goals, which are focused on through this game. Capability refers that the learner while playing the game develops some type of skills (cognitive, psychomotor, or affective skills). The users are engaged in the game to learn through learning activities. Reflection is a component where user gets feedback during the game, so that user can decide the next move during the gameplay and also think for the motives of the learning activities that are taking place, and Game genre brings up the type of game being played. Game mechanics discusses the procedure and the rules of the game that can help players to perform actions accordingly. The Game achievements are identified by the learner are known as learner achievements. The author of the model has discussed 11 game attributes which include: incremental learning, linearity, attention span, scaffolding, transfer of learned skills, interaction, learner control, practice and drill, intermittent feedback, rewards, situated and authentic learning and accommodating to the learner's styles.

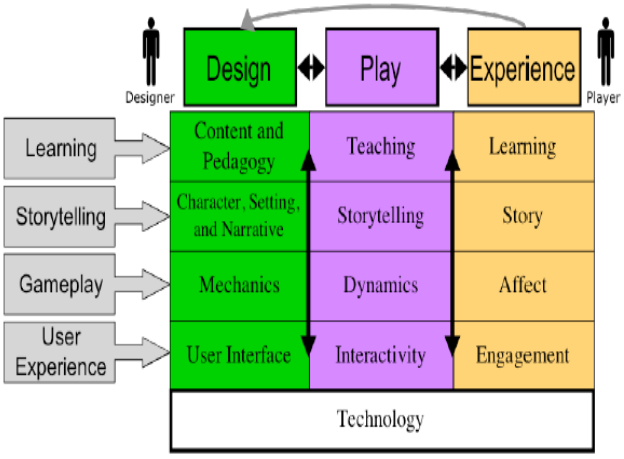

Figure 1. Expanded DPE Framework by [22]

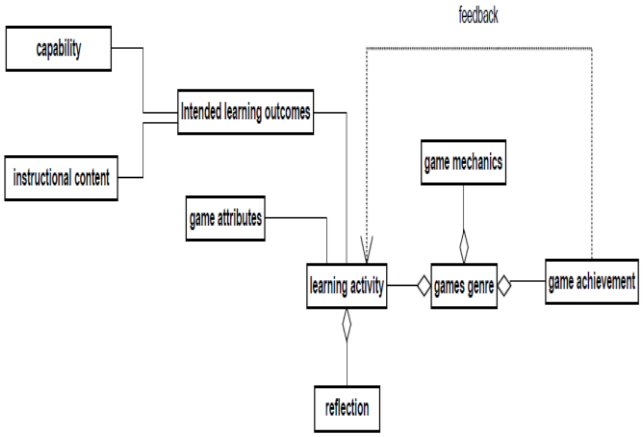

Figure 2. Conceptual Framework for Serious Games shown as a Structural Class diagram [23]

C. Educational Game Design framework

A framework proposed by [24] is for the design of the educational game as shown in Fig. 3. These game components in the framework are nested among each other. This framework deals with research with the theories in education and psychology, focusing on instructional technologies and learning sciences. The base behind the development of components of this model is the existing literature studies that have focused particularly on the educational games for classrooms from level 5 to the graduate level. For the design and development of such game frameworks for classroom learning, the emphasis is given on the user's unique identity in the game which may serve as a motivating factor for the user to get him/herself engaged with the given learning environment. User interaction in the game with other players also plays an important role to keep users immersed in the learning environment which may involve interaction with different players, virtual agents or the system itself. Complexity or moving to the next levels in the games also show users interactivity and immersion with the game. Informed teaching deals with giving the assessment and feedback of the gameplay in a timely manner to the users and the instructional component depicts how the learning will take place using the game environment.

Table 1 provides the summary of these three frameworks: [22], [23] and [24]. These frameworks have 15, 9 and 6 components respectively. The educational game design framework by [24] has its own structure whereas DPE framework of [22] has used MDA by [29] and the framework of [23] extends IPO by [30]. The structure of these frameworks is generic. A framework by [24] is used to design such games that need to improvise various skills in children while using the other two frameworks, games that focus on skills and contents for any kind of user.

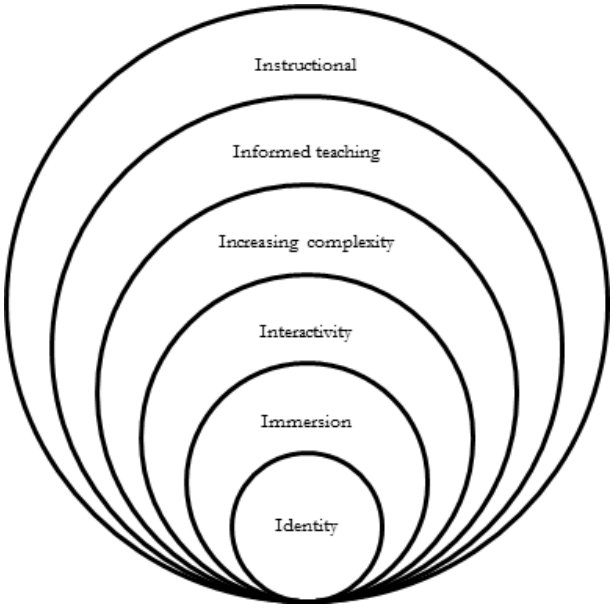

Figure 3. Redrawn nested elements of educational game design by [24]

TABLE 1. SUMMARY OF FRAMEWORKS FOR GAMES

Citation	Components			Underlying structure	Type
(Winn, 2009)	1. Content 2. Pedagogy 3. Teaching 4. Learning 5. Character	6. Settings 7. Narrative 8. Storytelling 9. Story 10. Mechanics	11. Dynamics 12. Affect 13. User Interface 14. Interactivity 15. Engagement	MDA by (Hunicke, Robin; LeBlanc, Marc; Zubek, 2004)	Generic
(Yusoff et al., 2009)	1.Capability 2.Instructional Content 3.Intended Learning Outcomes	4.Game attributes 5.Learning activity 6. Reflection	7. Game mechanics 8. Game Genre 9. Game achievement	IPO by (Garris et al., 2002)	Generic
(Annetta, 2010)	1. Identity 2. Immersion 3. Interactivity	4. Increasing complexity 5. Informed teaching	6.Instructional	Own Structure	Generic

IV. EXISTING MODELS FOR GAME BASED LEARNING

This section describes the models being used for the DGBL. The objective of this review was to find out:

1. the common components from different game design frameworks that are used for leaning
2. the relevance for the children or any user.
3. Either the type of framework is general purpose or specially designed for a particular domain

The search scheme used in this section to perform review is the same as described in section II. From the literature search, two models been selected for further investigations[30], [31].

A. *IPO model*

Garris et al. (2002) have presented a model input-process-output (IPO) for instructional and learning games which has been implemented as well used as a basis to design new models and frameworks by many researchers and educationists. The IPO model along with its components is shown in Fig. 4. The instructional content component consists of the contents and materials to be used for the learning of users through the game. Game characteristics component refers to the features of the game that plays role in learning and engagement of the user. The characteristics of the IPO model include fantasy, rules/goals, sensory stimuli, challenge, mystery and control. The user usually creates various subjective judgments in their mind as they start playing the game to determine if the game is fun, interesting and engaging. The affective judgments that are formed from initial and on-going gameplay determine the direction, intensity, and quality of further user behavior. Learning outcomes are the objectives that are expected to be accomplished after playing serious games. Debriefing is to perform the reviewing activity of the process and flow of the game. This model has three parts namely, input, process and outcomes. In the input phase, the user is provided the instructional contents combined with the game characteristics. In the process phase, user judgment, user behavior, and system feedback in a cycling manner to show the process or working of the game. The last phase is the outcome phase, in which learning outcomes are assessed.

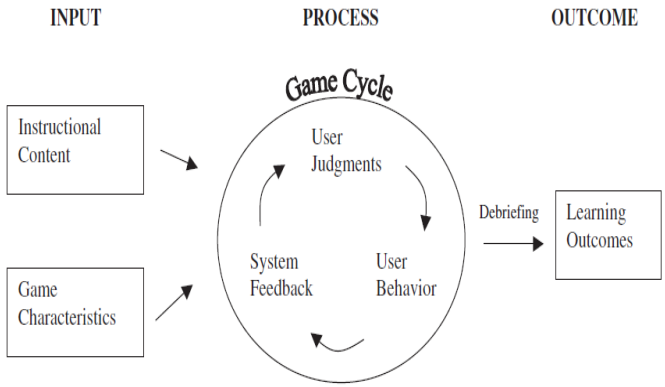

Figure 4: Input-Process-Outcome Game Model by [30]

B. *History Education Game Design Model*

[31] has developed a model Digital Game Based Learning – Instructional Design (DGBL-ID) by studying the existing models that can support Instructional Design(ID) for history based learning is shown in Fig. 5. DGBL-ID model combines the ID with the game development process. The author presents two components in the model namely, first pedagogy, which is further divided into six components and

second digital games, which is further subdivided into eight components. A total of fourteen components have been identified from the model, namely learning goal setting, learning theory setting, educational psychology, country curriculum needs, patriotism and memorization, forgetting theory, game story's background, rules, immersive, enjoyment, feedback, multimedia technology, challenge & competition, and reward/award.

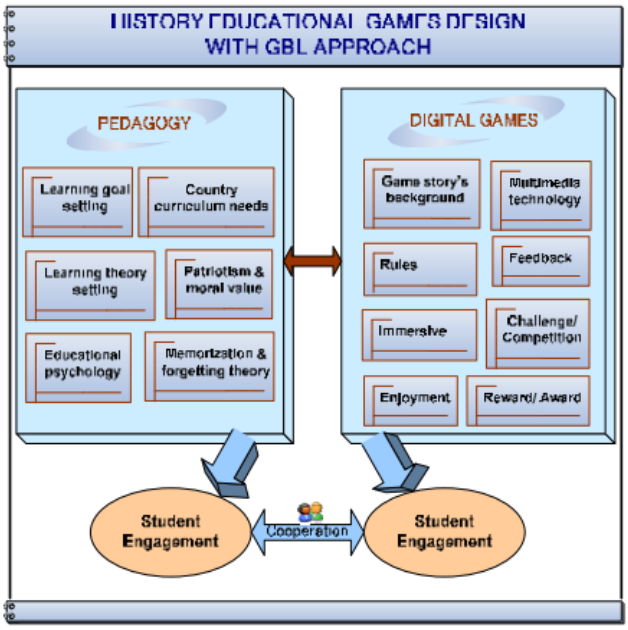

Figure 5. Proposed components in DGBL model for history educational game design [31]

Table 2 provides a summary of the two models [30] and [31] The model [30] has 7 components and the model [31] presents 2 main components which are further divided into 14 components. Both models have created their own structure The structure of the model by [30] is a generic model whereas the model by [31] is specifically for history course educational game.

V. Discussion & Results

This section discusses the key findings from the review of three frameworks and two models.

A. *Components of the framework and model*

Comparing the components of the frameworks (Table 1 in section III), it can be seen that there are 30 components in three frameworks which include 15 from [22], 9 from [23] and 6 from [24].

The components from frameworks [22] and [23] contribute towards the design of serious games for general users while components from [24] contribute towards the development of games from children's perspective.

As it can be seen from table 2 in section IV, there are 21 components i.e. 7 from [30] and 14 from [31]. The components from the model [30] contribute towards the design of serious games for general users while the components from the model [31] contribute towards the development of the game for history based courses.

After the review of 3 frameworks and 2 models, 51 components were found as discussed in section III and IV. These components have been further analyzed and synthesized to identify similar components and eliminate any repitition in components within and among frameworks.

Table 2. Summary of the model for games

Citation	Components	Underlying structure	Type
(Garris et al., 2002)	1. Instructional content 2. Game characteristics 3. User judgment 4. System feedback 5. User behaviour 6. Debriefing 7. Learning outcomes	Own structure	Generic
(Zin et al., 2009)	1. Learning goal setting 2. Learning theory setting 3. Educational psychology 4. Country curriculum needs 5. Patriotism and moral value 6. Memorization and forgetting theory 7. Game story's background 8. Rules 9. Immersive 10. Enjoyment 11. multimedia technology 12. Feedback 13. challenge/competition 14. reward/award	Own structure	History educational game design

B. *Underlying structures used in framework/model*

From the three frameworks and two models, the framework by [23] has used as a basis, the input process output (IPO) model by [30], and the framework by [22] has used mechanics, dynamics, and aesthetics (MDA) framework by [29] as a base to construct their framework, while the remaining framework and model have constructed their own structures.

C. *Type of framework and model*

From the three frameworks and two models, it was found that the model by [31] is a specialized model to design serious games for history based courses. The other frameworks and the model are generic, as these can be made as a base to design different types of serious games based on the needs of the user.

VI. Grouping of Components from Framework and Model

The 51 components have been identified from three frameworks and two models as shown in earlier sections. These components are further being analyzed here in this section to combine similar components within and among frameworks/models.

A. *Grouping of Components within frameworks/model*

While going through the descriptions of individual frameworks/models, it was found that some of the components within the framework/model are logically

related to each other. Firstly, the components whose description is logically related, are identified and place as a single component. The new name given to the component can be the same in the current framework/model, or it can be the same in other frameworks/models provided the purpose and description of the component is the same. For example, educational psychology and patriotism and moral values in [31] are related components and given name as learning activities. Table 3 shows all the related components within the framework/model which have been merged together to form a new component.

TABLE 3. GROUPING OF COMPONENTS WITHIN THE FRAMEWORK/MODEL

Similar Component within the framework/model	**Citation**	**New Component created**
System Feedback and debriefing	[30]	System Feedback
User Judgement and user behavior		Learning Activity
Character, narrative, setting, story, story telling	[22]	Narrative
dynamics and affect		Dynamics
User interface, interactivity		User interface
Teaching and pedagogy		Pedagogy
Immersive and enjoyment	[31]	Immersive
Patriotism and moral values, memorization and forgetting theory, educational psychology		Learning activity
Learning goal settings, learning theory settings		Leaning outcomes
Identity, Interactivity and informed teaching	[24]	Interactivity
Capability, intended learning outcomes	[23]	Intended learning outcomes

B. Grouping of Components among frameworks/model

After identifying similar components in the earlier section framework/model, it was also observed that there are similar components across the framework/model. The first finding was that in some cases components across have a similar name, for instance immersive in [31]and immersion in [24]. In other instances, components were having different names but their description complement each other like feedback in [31]and reflection in [23]. Similarly, all the components were identified having a similar name or similar description and given a new common name. Table 4 shows all the related components among frameworks/model and their citations, along with their new component name.

TABLE 4. GROUPING OF COMPONENTS AMONG THE FRAMEWORK/MODEL

Similar Component among the framework/model and citation	**New Component created**
Learning activity [30] [23][31] Learning [22]	Learning Activity
Pedagogy [22] Game attributes [23] Game characteristics [30]	Game attributes
Instructional content [30] and [23] Content [22] Instructional [24] Game story's background[31]	Instructional content
Learning outcomes [30] and [31] Intended learning outcomes [23]	Learning outcomes
User interface [22] Multimedia technology [31] Interactivity [24]	User interface
Mechanics [22] Rules [31] Game mechanics [23]	Game mechanics
Game genre [23] Country curriculum needs [31]	Country curriculum needs
System Feedback [30] Reflection [23] Feedback [31]	Reflection
Increasing complexity [24] Challenges/competition [31]	Challenges
Game achievement [23] Reward/award [31]	Rewards
Immersion [24] Immersive [31]	Immersive

There are two components that did not have any similar components across the framework/model i.e. dynamics and narrative. Therefore, these two components have been considered as independent components.

After grouping similar component (table 3) and eliminating redundant components (table 4), a total of 13 components have been identified out of 51 components. Table 5 shows these components mapped with the frameworks/model earlier discussed.

VII. CONCLUSION

Based on the review of existing literature, the models and frameworks for the game based learning generic models and course specific models have been considered. Thirteen

components have been identified by grouping components. These 13 components can be used by the researchers to develop and design games for the history based courses.

TABLE 5. COMPONENTS WITH THEIR FRAMEWORK/MODEL

S #	Game Components	Model for History based game	Framework for typical children	Framework for typical users		
		[31]	[24]	[30]	[22]	[23]
1	Learning Activity			✓		✓
2	Game attributes			✓		✓
3	Instructional content			✓	✓	✓
4	Learning outcomes			✓		✓
5	User interface				✓	
6	Game mechanics	✓			✓	✓
7	Country curriculum needs	✓				
8	Reflection	✓		✓		✓
9	Challenges	✓	✓			
10	Rewards	✓				✓
11	Immersive	✓	✓			
12	Narrative				✓	
13	Game Dynamics				✓	

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