

A Reflective Game Design framework for Game-Based Learning

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Abstract: Reflective practice is the ability to revisit and reassess one's previous actions to engage intentionally in the process of learning. The concept of reflection leads from unconscious aspects of learning or experience to mindful awareness, giving an individual the power to absorb everyday experiences to make appropriate conscious choices. Digital games in game-based learning (GBL) offer interactive learning with authentic practice and a high retention rate. Digital games are also considered an immersive and safe medium of stealth learning with the freedom to identify, explore, fail, and then retry. Main game elements such as feedback in a user interface (UI), head-up displays (HUDs), maps, prompt messages, and social discourse are reflective in nature; therefore, by default, games are reflection machines and appropriate mediums for triggering and supporting reflective learning. However, despite reflective learning having the ability to improve teaching and learning experiences in a practical form, work dedicated to reflective design in GBL is still limited. Previous studies have incorporated reflective practices into a learning environment to improve the learning rate. These practices may vary over domains and yield different outcomes that are not converged yet. While current game design comprises all features that facilitate reflection "as a whole set", it misses individual reflection differences. However, getting maximum usage of the reflective nature of games with authentic learning content while maintaining the fun criteria can be challenging. Hence, a sound design methodology and guidelines are needed to assist the game designer in aiding effective learning with reflective practices. In this paper, our primary purpose is to align reflective learning practices with existing GBL approaches and then provide a framework to incorporate reflective learning practices into designing GBL. The intention is that this framework will help designers, educators, and researchers to design game-based learning experiences following reflective design practices.

Keywords: Reflective design, game design, game-based learning, reflective learning, framework, learning cycle

1. Introduction

Digital games have now become an important part of our society (Oblinger, 2004) and are particularly popular with children, adolescents, and young adults (Mumtaz, 2001). Thus, digital games play a vital role in people's lives outside school, by holding a particular attraction with fascination and provoking a deep sense of engagement in them (Facer et al., 2004).

In spring 2020, gaming quickly emerged as one of the most popular activities during the initial outbreak of the global COVID-19 pandemic as user engagement and spending surged between February and April of that year. Especially younger generations Gen Z and Millennials spent more time on gaming as the medium was a convenient way to spend time during the initial stay-at-home orders, lockdowns, and social distancing (Clement, 2021). Additionally, a study by Jaeger et al. (2020) showed that globally there was a permanent 21% increase in monthly spending by gamers, an 11% increase in time spent gaming, and a 40% increase in video game streaming during May and June 2020 versus pre-COVID-19 (Jaeger et al., 2020). Hence, digital games in are getting a double boost among youngsters.

Digital games have already been accepted as a suitable learning medium for education and training (Gee, 2004). Games and Learning Publishing Council published a survey on teaching with digital games which suggests that 55% of nearly 700 teachers have used games for students to play at least weekly (Takeuchi & Vaala, 2014). Serious games, Game-based learning (GBL), e-learning, and gamification have also been gaining much interest in academia and the fields of edutainment (Martens & Müller, 2017). All these concepts overlap and possess each other's elements. GBL is an active technique where game characteristics and principles (i.e., gamification, learning goals, pedagogical methods) are embedded within learning activities and yield a suitable medium for learning. According to Prensky, GBL can help ease and improve learning by making it exciting, thus supporting motivational gain with engagement in the student's learning (Prensky, 2003). In GBL, "Play" is a vital aspect because it enables learners to learn through connection and interpretation with their surroundings, i.e., physical and social worlds (Gee, 2004). GBL uses gaming technologies and techniques to create a fun, motivating, and interactive virtual learning environment that promotes situated experiential learning (Fotaris & Mastoras, 2019).

The rest of this paper is structured as follows; Section 2 discusses the Background and literature review, Section 3 presents the existing GBL framework and then proposes a new reflective design framework, and section 4 concludes the paper with future work.

2. Background and Literature Review

2.1 Reflective Learning

John Dewey introduced reflection in the thinking process and its effects on skill development (Dewey, 1933); furthermore, he explained reflection as an activity that includes revisiting and reassessing previous beliefs intentionally and proactively. The concept of reflection leads from unconscious aspects of learning or experience to mindful awareness, giving them the power to absorb everyday experiences to make appropriate conscious choices. Moreover, reflection refers to consideration or serious thought for individual reasoning (Sengers et al., 2005). It also allows individuals to apply and develop their knowledge and skills in a learning domain. The concept of "Critical reflection" plays a vital role in a person's freedom and quality of life. In acquiring a skill, reflective learning stages are shown in Figure 1 such as 1) Serious thought or consideration; 2) Reasoning; 3) Construction of understanding and planning; and 4) finally, Applying and developing knowledge learned skill. Hence, it allows an individual to apply and develop their knowledge and skills (Schon and DeSanctis, 1986). Critical reflection plays a vital role in both one's freedom and quality of life in society as a whole. Reflective learning varies from person to person; it does not come naturally as they usually need a reason, trigger or encouragement to reflect (Fleck and Fitzpatrick, 2010).

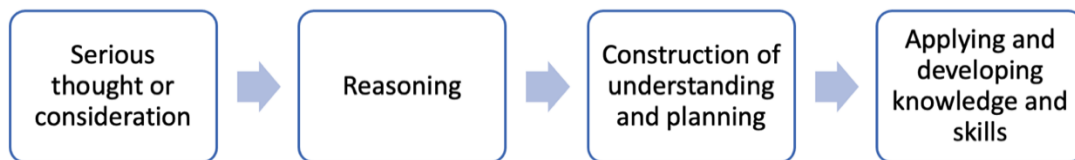


Figure 1: Learning Stages through Reflection

In a definition by Mezirow (1994), "*reflective learning is the social process of constructing a new or revised knowledge/interpretation of one's experience as a guide to action*". Reflective learning is related to behavioural change by rethinking an event or knowledge with the intent to re-organise it with creativity and/or to do something differently (Fleck and Fitzpatrick, 2010). This level of reflection can be achieved by revisiting an event by reflective and dialogic description while putting in a high level of thinking and, at the end, it becomes an integral part of human behaviour. Self-reflection encourages action, understanding, and co-learning, thus making reflective and critical learning a potentially significant guide (Gray, 2006). Furthermore, the process of *Reflection* can produce dramatic and sweeping changes in an individual (Allee, 1997).

2.2 Reflective Game Design

"Games are reflection machines" (Khaled, 2018)

According to Sengers et al. (2005), "*reflective design is comprised of design principles and approaches that lead designers to rethink the designing metaphors and values to encourage users to engage in the same practice with improved aptitude*". Thus, reflective design practices assist both designers and learners in a continuing reflection in the development of technology with their relationship to personal life experiences. Over the last few years, reflection has become an essential part of interaction design in human-centred design, i.e., reflection within technology (Sengers et al., 2005) and reflective game design (Khaled, 2018).

Reflective game design offers new prospects for research, e.g., exploring how educational games are a suitable medium to facilitate reflection and how they can significantly influence users' learning outcomes and behavioural changes (Khaled, 2018). Digital games possess distinct traits of freedom (Klopfer et al., 2009), along with the element of fantasy and curiosity (Malone, 1980) that help promote stealth reflective learning. They can also encourage interactive learning, help to overcome disengagement and provide authentic practice (Kapp, 2013). Therefore, games are a suitable mechanism for triggering and supporting reflection in serious games. Khaled (2018) proposed a list of principles that emphasise design qualities in reflective design and discourage certain conventionally accepted design qualities.

In their systematic review, Shaheen et al. (2021) identified how the following reflective design features which are currently used in GBL can enhance the learning process: 1) process displays and prompts improve understanding; 2) social discourse enhances user experience among players with active engagement; 3) process models validate users' learning, yielding learning confidence; 4) other reflective features, such as reflective modes, lead to improve critical thinking, problem-solving, and retention rate. Multiplayer role-playing games can also contribute to the improvement of the learning rate.

Despite the increasing incorporation of reflective design in GBL, there are still a few apparent limitations of practical implementation and using reflective design as a whole set instead of using it as a part. As the fast-growing trend of social collaboration is considered to be an important factor of public reflective learning, many GBL environments use social collaboration to enhance learning. However, it is hard to find a study that integrates a whole reflective social discourse within technology. For example, a few games in the reviewed articles have multiplayer in-action reflective features but offline post-gameplay assessments or debriefs. Many of these studies used offline peer collaborations, reflective assessments, and face-to-face workshops to enforce reflective learning.

Most of the studies have incorporated in-action social discourse by playing a game in a collaborative environment among participants (Foster et al., 2019; Hautopp & Ejsing-Duun, 2020; Henriksen & Lainema, 2010; Martin et al., 2011; Misfeldt & Gjedde, 2015; R uth & Kaspar, 2021; Sinensis et al., 2019; Van Lippevelde et al., 2016; Weitze, 2017). Network-based technology enables users to participate in a multiplayer environment; Orji et al. (2013) have developed role-playing multiplayer games to enable shared learning experience, collaboration and social reflection. Apart from in-action reflection (Schon, 1983), reflective design features are highly incorporated in post-gameplay as an on-action reflection in GBL. In this review, most of the studies were comprised of offline post-activity assessments (Foster et al., 2019; Henriksen & Lainema, 2010; Hwang et al., 2015; Rahmani et al., 2013; Wu et al., 2018) with guided instructions (R uth & Kaspar, 2021). Moreover, the post-competing reflective activity (Anderton & King, 2016; King, 2015; Orji et al., 2013), face-to-face post-play workshop on assessment (Martin et al., 2011), and self-reflection process of behaviour change identification technique are used for on-action reflection.

In addition to Schon (1983) in-action and on-action framework, researchers are now incorporating other reflective models, such as Gibb's Reflective Cycle (Gibbs & Unit, 1988) or Kolb's Learning Cycle (Kolb, 1984). Hence, it is a new research field to ensure reflective learning technique's accuracy, and there is a need to drive a mechanism to incorporate reflective learning measurement methods to identify design improvement.

2.3 GBL Frameworks

Games are one of the fastest growing sectors of the modern world, and are a commonly used entertainment source among young people (Ahmad et al., 2014; Tan et al., 2007). Various GBL frameworks have been developed over the years to best understand how games can be used to engage learners in course material. Killi's Experiential Gaming Model (Kiili, 2005) focuses on combining experiential learning theory, flow theory, and game design to create a successful GBL model. It emphasizes that the use of immediate feedback along with clear goals and challenges matched to the players' skill level allow for meaningful and engaging learning by experiencing flow. She found a lot of consistency in achieving the facilitation of flow, though, which makes the model unpredictable to follow. Furthermore, the model is suggested to be used for the design and analysis of educational games, and not for game development.

Components Elements	Pedagogical										Game Design											
	Difficulty to learn	Psychological needs	Critical thinking	Exploration	Challenge	Engagement	Competition	Practice	Goal setting	Motivation	Interaction	Storytelling	Interface	Simulation	Construction	Feedback	Literacy	Communication	Motor skill	Memory	Outcome evaluation	Total
Models/ Frameworks The Design Framework for Edutainment Environment	✓	✓			✓					✓	✓	✓									✓	8
Adopted Interaction Cycle for Games								✓	✓	✓					✓				✓		✓	6
The Engaging Multimedia Design Model for Children						✓		✓		✓			✓	✓	✓						✓	7
Game Object Model			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓		15

Figure 2: Matrix outlining key components of the 4 frameworks investigated in the development of AGBL (Tan et al., 2007)

The Adaptive Digital Game-Based Learning (AGBL) framework (Tan et al., 2007) identified key elements from 4 other GBL models and frameworks (see Figure 2). It has a preliminary focus on the pedagogical elements, such as psychological needs, cognitive development, and learning behaviours, in order to understand the learners’ learning abilities so that the game can be tailored toward the target group. Closely followed are the game design aspects, namely multimodal, tasks, and feedback. Unlike other models, which primarily focus on interaction in their game design, AGBL highlights the importance of engaging and motivating learners in the GBL environment using story, challenges, goals and objectives, with a focus on feedback and outcomes. This model places a good emphasis on the pedagogical elements of GBL, with the inclusion of multimedia elements to further engage players. The use of feedback and outcomes could be useful in encouraging reflection through gameplay.

GBL is a vast field now, and therefore, there is a gap in the literature about its core dimensions for comprehensive evaluation due to varying use of elements. In an effort to overcome the inconsistency in-game elements, scope, terminology, and definitions, Tahir and Wang (2018) expanded on GBL evaluation literature by conducting directed content analysis. Specifically, they analysed results to construct a hierarchical framework known as LEAGUE, which uses six core dimensions: Learning, Environment, Affective-Cognitive Reactions, Game Factors, Usability, and User. This framework provides a detailed overview of GBL elements and can act as a theoretical guide for designers, researchers and educational game developers.

In terms of cognitive engagement, Silpasuwanchai et al. (2016) proposed the Engagement Framework of Gamification for Learning in a study that investigated the use of gamification strategies to increase engagement, skill acquisition and transfer. This framework focuses on multi-faceted engagement (behavioural, emotional, and cognitive), users (internal states and characteristics) and tasks. Their research yielded that the use of multiple engagement dimensions is useful in different situations depending on the situation. In the post-study interview, they established that cognitive engagement was often high and even with a low emotional engagement, the effort (behavioural) and reflection (cognitive) which were put into achieving a good result stayed high.

Although games are inherently reflective by nature, very few of the previously mentioned GBL frameworks use active reflection methods or reflective practices to engage the player in learning. According to the literature review, only Kiili (2005) mentioned reflective feedback in her Experiential Gaming Model, even though her primary focus was on using the flow theory to develop a GBL. The development tool ctrl+R is designed to “prompt new – and reflective – ideas among game makers” through the “previously unconsidered creative avenues” (Goodine & Khaled, 2019) by presenting designers with eight random questions on digital “cards”. This tool could be useful in conjunction with one of the GBL models to enhance reflective game design.

3. Reflective Game Design (RGD) Framework

In literature, there are several reflective models (Argyris & Schön, 1978; Gibbs & Unit, 1988; Kolb, 1984) to guide reflective design in learning. Although each model is designed to induce reflective learning in a specific way,

Kolb’s Learning Model (Kolb, 1984), famously known as the “experiential model”, aligns with the GBL purpose as it is based on experiential design and enables concrete experiences. Kolb’s Learning Model, represents a process whereby knowledge is shaped through actual practice and experience transformation. This experiential cycle comprises four distinct stages, i.e., concrete learning, reflective observation, abstract conceptualization, and active experimentation. This continuous cycle assists effective learning throughout the learning process.

1. *Concrete experience* refers to gaining an experience by actual practice; it might be a new learning experience or a reevaluation/interpretation of existing knowledge in the light of new concepts.
2. After the concrete experience, *reflective observation* allows learners to revisit and reflect on reassessing their experience, such as learners should step back to reflect on the task or activity. Moreover, at this stage, critical reflection can be achieved by asking questions, discussing with peers and comparing new knowledge with previous experiences to look for patterns or notable differences.
3. Reflective observation leads to *abstract conceptualisation*; in this stage, learners form new concepts or modify their current understanding based on reflective observation. Abstract conceptualisation enables learners that are ready to apply their new learning or set of experiences in the real world.
4. The last stage of the cycle involves *active experimentation*, where learners actively apply their new skills to the world around them. At this stage, new learning is part of the learners' skill set and they are ready to enhance or improve their experience by experimenting with different ideas and opportunities. Active experimentation also leads to new ideas and innovations that can eventually become part of new concrete experiences that effectively trigger the beginning of the next cycle.

Authentic practice and reflective observation are the main components of the experiential learning model, and games are an excellent medium for providing authentic practice (Kapp, 2013) and reflective observation (Sengers et al., 2005). Thus, the primary purpose of the proposed RGD framework is to map game design elements with experiential learning and present a method to design GBL experiences that can improve reflective and authentic practice through games. Similarly to Kolb’s model, the RGD framework consists of four stages, where each stage is extracted from the original experiential learning model. Figure 3 depicts the assignment of game design elements to each stage of the Experiential Learning Cycle.

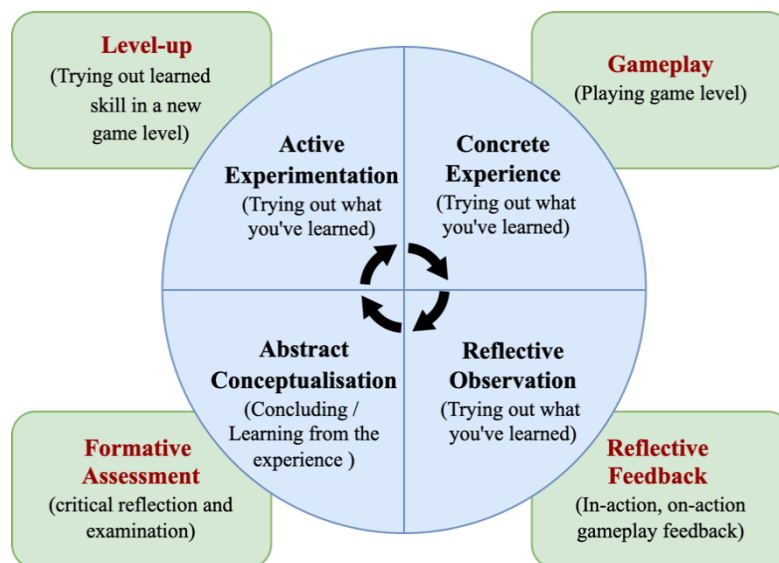


Figure 3: Experiential Learning Cycle (inner circle Kolb, 1984), and assignment of game design elements to each stage of the Experiential Learning Cycle

1. *Gameplay in GBL* enables learners to interact with a game to get an authentic practice and concrete experience of a learning objective. It is the pattern defined through the game rules, game mechanics, challenge, story, feedback, levels, and other game elements. Moreover, gameplay in GBL allows the freedom to replay and explore the content to improve learning skills. For instance, CodinGame (<https://www.codingame.com/>) is an online game-based learning solution that helps programmers to

The RGD framework is an iterative model, in which each iteration improves learning with reflective observation and authentic feedback. Reflective feedback is a central part of this framework as shown in Figure 5, thus, this framework embeds reflective learning elements in each stage with experiential learning (Kolb, 1984) methods

4. Conclusion and future work:

This paper primarily focused on presenting a reflective game design framework (RGD framework) that enables the use of the reflective nature of game elements in game-based learning. The RGD framework provides a mechanism to incorporate reflective learning in GBL approaches that will provide learners with reflective feedback at each stage of the RGD framework. Previous studies suggest that reflective design features in GBL improve the learning process, e.g., Heads-up displays improve understanding, social discourse enhances user experience with active engagement, and other reflective features, such as reflective models lead to improved critical thinking and problem-solving. Despite the importance of the reflective nature of game elements, previous studies have not addressed it entirely. Therefore, this study intends to add more knowledge and evidence in this field by proposing a reflective game design framework for GBL design and development. This framework is modelled after Kolb's learning cycle and maps game design activities with experiential learning theory.

In the future, this RGD framework will be implemented in the design of a serious game to improve self-awareness among youngsters, and its effectiveness will be evaluated accordingly. Moreover, the evaluation findings will be used to inform reflective game design principles and guidelines. Hopefully, this ongoing research will provide some insight and help GBL designers and researchers to implement reflective design in their practice.

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