Game-based reflective learning: a modular experience for teachers and students

Game-based learning riflessivo: un’esperienza di progettazione modulare per insegnanti e studenti

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ABSTRACT

Video games may represent an experience mediated by digital environments in which an immersive learning happens. Game-based learning (GBL) entails a high degree of metacognitive skills: learning is deeper when gamers are prompted to explain their thoughts and actions, to reflect on learning and on their self-regulation. To foster the metacognitive nature of GBL a modular reflective design framework (MO.RE.GBL) is proposed, focusing the phased construction of the learning process, the role of teachers and students’ autonomy and self-regulation, through a reflective approach. The framework can be used by teachers to design GBL activities or with their students to focus the learning process. Students may use it to self-regulate and personalize their GBL experience through the selection of their sequence of activities.

SINTESI


KEYWORDS: game-based learning, metacognition, reflective design

PAROLE CHIAVE: apprendimento basato sul gioco, metacognizione, progettazione riflessiva

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Introduction

Studies on immersive teaching and learning have been assuming the term “immersive” in multiple ways: initially, the idea of immersion referred either to the psychological construct of state of subjective perception of presence and interaction, or to the technological construct of feature and affordance of a technical system (Morgado et al., 2022). Recently, this dichotomy merged into a theoretical complementary view of immersion as the experience of a state of deep mental involvement, with or without sensory stimulation, in which cognitive processes cause a shift in the attentional state that may result in a disassociation from the awareness of the physical world (Agrawal et al., 2020, p. 6). In the immersion, the phenomenon of psychological absorption and feeling of presence originates from three dimensions: the technical system and its properties, the narrative content, and the challenges (Nilsson et al., 2016).

Immersive learning environments (ILEs) have been described as virtual, mixed, extended, and augmented reality environments which support active learning, autonomy and collaboration through multiple devices, such as 3D virtual worlds; virtual-, augmented-, and mixed-reality experiences and simulations, and digital serious games (Hayes et al., 2022). According to the literature, immersion may happen either with only 3D technologies (Korteling et al., 2017; Siegle et al., 2020), or with 3D virtual worlds even when displayed on a two-dimensional screen (desktop devices) (Hayes et al., 2022; Mills et al., 2019).

Video games could be defined as immersive environments (Taub et al., 2020) because they provide users with experiences otherwise unattainable in the physical world (Mikropoulos & Natsis, 2011, p. 770), they simulate real life situations and settings, and let users experiment with natural and social rules and emotions safely, making decisions and solving problems. Users receive specific feedbacks, and the environment is often adaptive to the level of their performance.

Taking on Nilsson and colleagues’ perspective (2016), we may assume video games as immersive environments because of their technological properties (e.g., the video game, the hardware), their narrative content (e.g., the story, the characters, the context), and the setting and the contextual conditions they enact (e.g., tackling challenges, making decision, collaborating; Beck et al., 2020).

1. The role of reflection in the learning process

The acknowledgement of the role of reflection in the learning process dates to Dewey (1933), who described it as the persistent, and careful mental processing of one’s internal problem-solving activity (Chen et al., 2009).

Reflection is a key feature that fosters learning processes such as memorizing and understanding (McNamara et al., 2006), by revisiting and assessing previous beliefs, as well as mindful and implicit aspects of the learning experience.

Reflection has also been characterized as the process of learning from experience (Schön, 1983), because it is an active process which involves the understanding of
the learning process and of oneself as a learner, along with critical thinking and the ability to organize, monitoring, and assess one’s learning to direct future performances (Lin et al., 1999).

In a virtual immersive environment, one may reflect on technology, or through technology (Sengers et al., 2005). This distinction particularly applies to video games, because they enact hard problem-solving and analytical reasoning, offering feedbacks helpful in the reflection on the consequences of every choice or move (Khaled, 2018).

Reflection verbal reports may concern relating, reasoning and reconstructing processes (high quality report) as well as reporting and responding on contents (low quality report; Bain et al., 1999). Reflection can be executed along the course of a task to foster the ability to adapt the action steps (Schön’s “in-action reflection”), or it may be a post-task reflection affecting the learning process as a whole and the ability to improve skills and experiences (“on action reflection”; Schön, 1983). It also may address either the outcome or the process beneath it (Lin et al., 1999) and it provides an opportunity to develop metacognitive strategies by creating personal connections between the curricular activity and play (Foster & Shah, 2015).

Reflection is more likely to be enacted in environments providing complex problems, which call for a larger amount of conscious decision-making (Flavell, 1987), such as in game-based learning environments (GBLEs; Fiorella & Mayer, 2012; Kim et al., 2009; Papert, 1993), that is why games have been acknowledged as “reflection machines” (Khaled, 2018, p. 6).

2. Does immersion go along with reflection?

Games are experiential systems whose strength lies in challenge and failure, as in reflection, which is not about reaching “correct” solutions, rather questioning and revisiting existing assumptions.

Nonetheless, most off the shelf games, as well as serious games, push users to act mechanically and optimize the results of each move, rather than to reflect on the meanings of their actions (ethics, social, strategic ones). Moreover, when the game environment is too fictional or simple, deep learning and transfer are not likely to occur, because situations are unrelated to real problems in the real world and they under-exercises metacognitive learning skills (e.g., problem framing and synthesis; Súilleabháin & Sime, 2010). Khaled argues that supporting reflection means privileging it over immersion: «If immersion is a quality we associate with playing – and losing ourselves in – games, then reflection is closer to finding ourselves in games and designing our own experience» (2018, p. 24).

When learning through a virtual immersive environment, such as video games, the quality and the ecology of the game experience should always be preserved. This constraint does not prevent the possibility to elicit the players’ self-awareness, critical reflection, and active interpretation before/after the game experience, or even during it, with a few preventative measures. The general practices that
designers and learners may undertake to support critical reflection in gaming, as well as individual customized reflection practices, have been referred to as reflective design (Sengers et al., 2005) or reflective game design (Khaled, 2018).

In GBLEs reflection may be entailed in the game or in the technological learning environment, or it may be prompted by instructional designers through external means. The optimum instructional scaffolding should provide reflection prompts throughout the learning process (King, 2015), mainly through open questions (Fiorella & Mayer, 2012). Still, there is a lack of evidence on whether teachers and students keep enacting reflective strategies in the long term and integrate them in the learning process (Coleman & Money, 2020).

As literature has been pointing out, reflection-based learning outcomes may vary along with the timing (before, during, or after the game), the prompting and the answer modality (e.g., menu based, written, spoken, video) (Hung et al., 2014), the extent of direction provided (Ifenthaler, 2012), and also with the content of the addressed reflection.

According to Lin and colleagues (1999), Reflective Design should entail four main features: process display (displaying otherwise implicit problem-solving and thinking processes; allowing students to analyze their progresses and to apply them in the ongoing actions); process prompts (suggesting specific questions or information before, during and after the problem-solving and the learning experience); process models (providing expert models to make comparisons); reflective social discourse (creating forum for community based discourse to share perspectives, experience, feedbacks, etc.). Indeed, reflection has been proved to be more fruitful when it happens in social interaction, benefiting from multiple perspective and feedbacks on students’ performance and understanding.

To enhance the perception of growth in one’s ability, the quality of experience in the GBLE might also be enhanced through four structural interventions (Romeo & Cantoia, 2011): first, the balance in the alternation between gaming and reflection activities, even by the support of screenshot, videos or extracts from the dialogue during the game.

The players should receive clear feedbacks in every phase of the game, either through information displayed in the interface of the game or external supports. Particularly, games seldom give feedbacks directly relevant to learning goals, a viable strategy could be to reformulate goals and feedbacks already present in the game by the means of a more explanatory class-lexicon, or still to pair the players (one plays, the other monitors the achievement of goals).

Finally, as many games already provide for, the dynamic balance between challenge and skill should be considered by instructional designers either when choosing the game, or by devising some internal or external performance evaluation system to adapt the difficulty level depending on the player’s performance (flow design).
3. MO.RE.GBL: a game-based learning design framework

Game based learning (GBL) is an instructional method based on the use of digital games, simulations, or gamified learning activities (Höyng, 2022), «a construction of cognitive structures through action or practice in the game world» (Kiili, 2005, p. 18).

The immersive environment of GBL entails a high degree of metacognitive skills: learning is deeper when gamers are requested to explain their thoughts, decisions, and actions, to reflect on their learning, to self-regulate and to reflect on how they self-regulate (Taub et al., 2020).

The GBL environment leads to more effective learning outcomes (Acquah & Katz, 2020; Yu et al., 2021; Flynn et al., 2021; Tokac et al., 2019), particularly when students develop a coherent mental model, they are provided with scaffolding and feedbacks and the learning process is based on self-regulation (Mayer, 2019).

Teachers need to be scaffolded in their technology integration (Mills et al., 2019; Morgado et al., 2022), both on the organizational restraints and needs (Chen et al., 2020; Foster & Shah, 2020; Molin, 2017) and on the cognitive processes involved when learning in an immersive interactive environment. The modular reflective design framework for GBL (MO.RE.GBL) is aimed at this latter goal. Reflection and metacognitive abilities can be acquired and trained even in GBL by focusing on the core learning processes, and on the value of the sequence of the activities to be developed. This framework tries and address the need for a reflexive approach to teaching and learning (Barr, 2018; Coleman & Money, 2020) as well as the crucial topic of the development of tools to foster reflection (Chen et al., 2009).

The MO.RE.GBL framework can be used by both teachers and students: teachers can use it to design a GBL activity together with colleagues in multidisciplinary projects. Students may use it individually or in small groups to self-regulate and personalize their GBL experience.

One of the main objectives of the design framework is to address the user’s focus on the identification of core processes and activities in learning. Teachers’ pedagogical assumptions are the foundations of the efficacy of virtual immersive environments, and they impact students’ engagement (Mikropoulos & Natsis, 2011), thus, for a more coherent and explicit approach to learning, it is important to support teachers’ awareness of their assumptions and practices (Antonietti & Cantoia, 2010).

The modular structure of the design framework allows targeted and weighted choices to be made regarding the sequence of activities to be developed according to both the specific educational objectives of each phase and the general aims. The possibility of adapting the sequence of activities also respond to the need to consider different cognitive styles and cognitive flexibility, allowing many different organizations of the main steps of the learning process. The modularity also encourages self-regulation skills, which develop as students monitor and control their thoughts and acts during the learning task (Winne & Azevedo, 2014). Self-
regulation is not a sequential process, it can be enacted repeatedly in each phase of the learning process (Zimmerman & Schunk, 2001).

The framework has its theory premises in the experiential circular learning model by Kolb (1984). According to Kolb, active learning involves both motor-behavioral and mental activity that take place in reflection, recall, comparison, organization or re-elaboration of contents, as well as in design, planning, and monitoring of motor actions. The framework also refers to the seven key tenets of student-centered learning by Lea, Stephenson, and Troy (2003): active learning; deep learning and understanding; increased responsibility and accountability; sense of autonomy; teacher and learner interdependence; mutual respect; reflexive approach to teaching and learning.

MO.RE.GBL design opens and ends with structured activities, in-between, four flexible modules can be arranged and repeated according to the learning purpose, the cognitive and learning style of the designer (the teacher or the group of students, see Figure 1).

![Figure 1 – MO.RE.GBL Design Framework](image)

3.1. Starting activities

The three main goals of the starting activities can be achieved either in small groups or by the whole class. First aim is to explore students’ beliefs and abilities on the topic at matter. Activities may consist of discussion, learning test, problem-solving, game-based activity, or other. This is a necessary step to assess the students’ starting level and to accordingly define the main objectives of the GBL unit (second aim). Activities based on video games elicit different abilities (cognitive, social, emotive, motivational, methodological ones), thus it is important to distinguish all affordance of the main purpose of the learning unit. The learning goals, defined together or presented directly to the class, should describe activities
and criteria of assessment, in order to define a common ground and allow students to make sense of what they will be doing.

The third aim is to become familiar with the video game and its rules. A warm-up session with the video game should be carried out during school time or at home. At the end of the exploration phase, students will fill a questionnaire to describe, according to their opinion, the objectives, the game modes, unclear elements and the relevance of the video game to the subject (“In your opinion, why and how will this game allow you to learn ‘the topic’?”). The discussion of the results of the questionnaire with the students, to share a common understanding of the video game and the GBL unit, is a core point, because learning implications of games must be explicitly addressed to later achieve learning transfer (Crookall, 2010).

3.2. The four modules

To get started with the learning experience, the designer may choose among four modules to be autonomously organized and eventually replicated, according to the learning goal, the individual learning/teaching style, personal preferences, and previous experiences.

Teachers, who are not familiar with games, might benefit of a direct “gameful” experience to grasp the processes and the dynamics activated in gaming. Beyond testing the game, they will use in their class, the gamification of the design process could help them, as well as the students, to learn first-hand how a goal can be reached through the game. Teachers could also share the planning with their students to focus their attention on the methodology applied. In both cases, emphasis will be put on the reason for one’s choices. Cards representing the four modules could be distributed among participants who will discuss on the sequence to be defined with the support of two decks of cards to activate self-regulation skills: the “Think” cards to suggest metacognitive hints or critical questions to monitor the learning process and the management of the group work; the “Ask” cards as a pass to ask for explanations or help from other groups, the teacher, or colleagues. The request for support expresses the ability to envision critical issues and limits in one’s work, and it also involves the ability to know how to ask a good question, therefore it should be valued.

The four modules to be customized are:

- Playing: according to the phase of the sequence, gaming might serve distinct roles: starting point, main learning environment, assessment, training, etcetera;
- Knowing: this module is meant to acquire or deepen the knowledge on the topic through frontal lessons, learning materials devised by the teacher (notes, presentations, videos), or research carried out in groups or individually. Information may be useful to solve puzzles in the game, or may be hinted by the gameplay, depending on the sequence of the modules. The management of this module fosters the sense of autonomy and responsibility of the student,
teachers may facilitate this taking charge, providing materials and support, when it is required;

- Applying: in this module, students apply and exercise the content or the ability they gained through gaming to verify their comprehension and knowledge and to favor the generalizations of the learning outcomes in different contexts, even out of the game-environment;

- Monitoring: this module is about self-monitoring activities to reflect on the experience, the contents, the need for eventual adjustments, one’s wellbeing and self-efficacy. Prompts to reflect may be sorted randomly or according to category (content, strategies, method, experience). For example: “What have you done to this moment?”; “What are you still supposed to do?”; “If asked what are <the topic> characteristics, would you be able to explain them?”; “How are you working?”; “At the beginning, had you correctly assessed the commitment to this activity?”; “Is it a good experience?”; “What are the main difficulties at this moment?”; “So far, which aspect surprised you the most?”; “So far what have you learned?”; “So far, are you comfortable with this GBL unit?”.

3.3. Final activities

The unit ends with the assessment of the learning outcomes at multiple levels by both the teacher and the students. Every student undertakes a personal learning test to assess their level of acquisition and the groups conduct an authentic assessment activity, to verify their ability to engage in a different environment (learning generalization and transfer). Students and/or groups also assess their outcomes, their ability to work as a team, and the accomplishment of the learning goals in terms of content (“What have I/we learned?”), ability (“What have I/we learned to do?”), and method (“How have I/we learned?”; “Was the gaming activity effective?”; “How could I/we have done otherwise?”; “What were the most useful modules for learning?”; “What should I/we do next time?”). The focus on the effectiveness of gaming during the learning process is useful to prompt students to compare traditional learning strategies to game-based ones. General metacognitive reflection on learning method, cognitive and learning styles, and the analyses of the sequence of the modules is also suitable.

Conclusions

GBL design process encompasses at least three different perspectives: the immersive technological environment, its characteristics and effects on the learning process; the gaming environment, the skills related to gaming practice (single, and multi-player) and the actual learning potential of the game; the instructional design, considering students’ characteristics, learning contents, learning goals (education, topic, instruction, key objective), methodologies, and the evaluation system (starting levels, monitoring, outcomes, maintenance in time). Reflection may enhance the awareness and the extent of the expected outcomes at all levels and should be prompted along all the learning process.
Albeit the availability of solid GBL models, teachers, especially novice, have been proved to find it difficult to apply them in the light of multiple reasons as time constraints, unavailable resources, need for training and technical support (Morgado et al., 2022). Even the first attempt to apply this framework during the pandemic in 2021 proved to be quite demanding for teachers (Cantoia & Tinterri, in preparation). The period proved very difficult for teachers, and they tended to devote all their efforts to the new methodology (GBL), trying to adapt and integrate it to more familiar frames of instructional design. The ability to manage a virtual learning environment is based on the awareness of its implications and requirements at multiple levels, so the feedbacks from teachers were valuable to further value the role of prompts for reflection in MO.RE.GBL, in order to be more effective to teachers in their GBL designing experience.

Prompts to reflect are the way to good learning performances (Aleven & Koedinger, 2002), and they should address self-regulation abilities at all levels, cognitive, metacognitive, affective and motivational ones (Azevedo et al., 2019). Focusing the phased construction of the learning process, the core role of teachers and students’ autonomy and self-regulation, and the crucial role of a reflective approach seems to be a promising way to a complete, effective learning experience.

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