Serious Games Put to the Cognitive Test: Pedagogical Potential and Cognitive Pitfalls for Students with Academic Difficulties

الألعاب الجادة على محك المعرفية: الإمكانات البيداغوجية والعقبات الإدراكية لدى التلاميذ المتعثرين دراسياً

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Abstract:

This study offers a critical analysis of the literature on the impact of Serious Games on the learning of students with academic difficulties, particularly in French language acquisition. These devices present two faces. On the one hand, they can increase motivation, reduce fear of failure, and foster engagement. On the other hand, they carry cognitive and pedagogical limitations: the risk of cognitive overload, the need for enhanced teacher scaffolding, and the difficulty of adapting to heterogeneous learner profiles. The analysis shows that their effectiveness depends largely on their integration into a structured pedagogical scenario and on teacher mediation, which rules out seeing them as a universal solution. The article thus identifies the conditions under which Serious Games can genuinely serve students with academic difficulties, and highlights the contradictory effects likely to undermine their pedagogical value.

Keywords: Serious Games, Academic difficulties , Active Pedagogy, Cognitive Load, Motivation

ملخص:

تقدّم هذه الدراسة تحليلاً نقدياً للأدبيات المتعلقة بتأثير الألعاب الجادة على تعلم التلاميذ الذين يعانون من صعوبات دراسية، لا سيما في اكتساب اللغة الفرنسية. وتتّسم هذه الأداة بوجهين: فهي من جهة قادرة على زيادة الدافعية، والحد من الخوف من الفشل، وتعزيز الانخراط؛ ولها من جهة أخرى حدود معرفية وبيداغوجية، منها مخاطر العبء المعرفي الزائد، والحاجة إلى دعم أكبر من المدرس، وصعوبة التكيف مع تنوع خصائص المتعلمين. ويبيّن التحليل أن فعالية الألعاب الجادة تتوقف في جانب كبير منها على إدماجها ضمن سيناريو

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بيداغوجي منظم وعلى وساطة المدرس، مما يمنع اعتبارها حلاً شاملاً. وتحدد المقالة الشروط التي يمكن في ظلها أن تخدم هذه الألعاب التلاميذ الذين يعانون من صعوبات دراسية فعلاً، كما تبرز الآثار المتناقضة التي قد تُضعف قيمتها البيداغوجية.

الكلمات المفتاحية: الألعاب الجادة، صعوبات دراسية، البيداغوجيا الفعالة، العبء المعرفي، الدافعية

1. Introduction

Morocco, like many other education systems, faces persistent academic difficulties. National and international assessments leave little room for doubt: only one in three primary school students masters basic reading and writing skills (INE-CSEFRS, 2022; UNICEF, 2015). To this finding are added the absence of quality inclusive programs, insufficient monitoring of learning outcomes, and the low quality of learning, all of which hold back improvements in success rates (UNICEF, 2015). It is in this context that Serious Games are presented as a path toward pedagogical renewal, particularly for students with academic difficulties (Alvarez, 2015; Lavergne-Boudier, 2010).

Learning through play is not new, but digital technology has given it unprecedented scope, in informal education as well as at school. The Serious Game, understood as a digital application that combines a predefined pedagogical scenario with a ludic dimension, aims above all to increase learners' motivation and to mobilize their attention, energy, and reasoning in the service of a learning objective set in advance (Alvarez, 2015). It is all the more appealing because it seems to match the habits of a generation of "digital natives" (Beddaou, 2019) and because, according to Lavergne-Boudier (2010), it would bridge the gap between an attractive multimedia society and a school still attached to academic modes of knowledge transmission.

This enthusiasm nevertheless deserves qualification. Research findings remain inconclusive, and the polysemy of the term fuels confusion: the Serious Game is often reduced to the mere entry of video games into school (Beddaou, 2019). Field experiments also reveal limitations, particularly in the face of audience heterogeneity and reading difficulties (Mandart, 2019). A question therefore arises: do Serious Games constitute a genuine lever for students with academic difficulties, or do they impose new cognitive constraints on them? We approach this question from the standpoint of cognitive psychology, focusing on the attentional, motivational, and memory-related mechanisms involved. After clarifying the notions of academic difficulty and Serious Game, we will examine in turn their potential and their limits, before outlining the conditions for a reasoned use.

Our approach is a critical analysis of the French- and English-language literature on Serious Games, language learning through play, and academic difficulty. The aim is less to measure the effect of a particular game than to confront the arguments advanced in favor of these devices with the cognitive constraints of students with academic difficulties, in order to identify conditions of use rather than a general verdict.

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2. Conceptual Framework

2.1. Academic Difficulty: A Polysemous Notion

Learning, as shaped by the currents of psychology in the twentieth century, has profoundly transformed teaching and pedagogical practices. Applied to school, it designates a dynamic process through which the learner, by means of a series of exchanges with peers and the teacher, connects existing knowledge with codified knowledge in order to build new knowledge (GUIMFAC, 2022). It remains to specify which difficulties are at stake.

Academic difficulty is a common expression, but it covers very different realities. A first distinction must be drawn between learning difficulties and learning disorders. The former are often temporary and call for adapted pedagogical measures. The latter refer to a dysfunction in the process of acquiring knowledge (Pohlman et al., 2011), more precisely to the impairment of a specific cognitive function (Farriaux & Rapoport, 1995), and require the intervention of specialists, such as psychologists, speech therapists, or physicians, rather than that of the teacher alone. A student who is failing may present such dysfunctions without this constituting a disability in the strict sense. Most often, academic difficulties, understood as a gap relative to the minimum level of attainment expected at a given moment, remain within teachers' reach (Delel, 2014).

Meirieu (2008) refines this distinction by contrasting students "in difficulty," who need more time to learn and are usually addressed through remediation procedures, with students "in failure," who have broken with the institution and call for a "genuine alternative." According to Myara (2003), the student in difficulty is engaged in a project of learning but does not know how to go about it, whereas the student in failure does not perceive the stakes of the work and does not feel concerned (Estance, 2014).

The expression in fact covers even more varied profiles. Boucharlat and Auger (1999) include the student whose work methods are inadequate (Vianin, 2009), the disruptive student, the student who refuses to work, and the student with no professional plans. It can thus designate a low academic level, behavioral problems, a refusal to work, or all three at once. Charlot, Bautier, and Rochex (2000) add that this disengagement also depends on the meaning students give to knowledge: they value or devalue it according to what it represents for them. This heterogeneity is essential for what follows, because it explains why the same tool can motivate some students while leaving others indifferent, or even in difficulty.

2.2. The Serious Game: Definition and Typologies

Popularized by Abt (1970), the concept of the Serious Game combines "the seriousness of thought and the problems that demand it, and the experimental and emotional freedom of active play." We will retain here the definition of a digital device designed specifically for learning and training, which thus departs from mere entertainment. It combines clearly defined training objectives (serious dimension) with a gaming environment, realistic or artificial, featuring rules and challenges (ludic dimension) (Alvarez, 2007; Plante, 2016; Sauvé, 2008).

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Two distinctions help to situate it more precisely. The first contrasts it with Computer-Assisted Simulation (CAS). For Mandart (2019), the Serious Game offers a "scripted exploration," in which the student plays with the knowledge to be taught, whereas CAS offers a "scientific exploration," in which the student manipulates the knowledge itself. The Serious Game thus integrates the pedagogical scenario into the game, whereas CAS requires external pedagogical contextualization. The second distinction contrasts it with gamification, which consists of adding game elements to an existing learning environment to make it more motivating, without the learning task itself really changing (Plante & Angulo Mendoza, 2022).

Several typologies also exist. Sauvé (2008) distinguishes the educational game, whose learning objective is implicit and whose pleasure is extrinsic, from the pedagogical game, whose objective is explicitly identified and whose pleasure is intrinsic to performance. Loisier (2015) classifies Serious Games according to their general objective into ludo-pedagogical games, simulations, and role-playing games. These classifications remind us that the same label covers tools with different learning logics, which prepares the question, addressed later, of the choice of game.

2.3. Theoretical Landmarks: Motivation, Working Memory, and Scaffolding

Three frameworks from psychology help to read the dual dimension of Serious Games, motivational on the one hand and cognitive on the other.

The first concerns motivation. Self-determination theory distinguishes intrinsic motivation, which drives people to act for the interest or pleasure of the activity itself, from more controlled forms of motivation that depend on rewards or external pressures, and it emphasizes the role of feelings of competence and autonomy in engagement (Ryan & Deci, 2000). For a student with academic difficulties, who has often lost the feeling of being capable, a device that returns graded successes can help restore this sense of competence, provided that the challenges remain within reach.

The second framework is that of working memory. Baddeley and Hitch (1974) described a limited-capacity system responsible for temporarily maintaining and manipulating the information needed to carry out a task. Cognitive load theory (Sweller, 1988) draws consequences from this for the design of learning situations: elements that do not contribute to understanding the task consume resources that are then lacking for learning. This perspective is directly relevant to Serious Games, whose images, sounds, rules, and instructions simultaneously draw on the player's attention. It is all the more relevant for students who read with difficulty, since decoding written instructions may already occupy a substantial share of their resources.

The third framework is that of scaffolding. Wood, Bruner, and Ross (1976) used this term for the help provided by an adult that allows the learner to carry out a task they could not accomplish alone, and that is withdrawn as the learner's competence grows. This notion sheds light on the teacher's role in the use of a Serious Game: the point is not to leave the student to

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play alone, but to adjust support to the obstacles encountered, whether reading an instruction, understanding a rule, or linking action in the game to the targeted knowledge.

These three landmarks structure the rest of the analysis: the first accounts for what the game contributes, the other two for what it may cost.

3. Analysis: The Dual Face of Serious Games

3.1. Motivational and Cognitive Potential

The first asset of Serious Games lies in their capacity to generate motivation and engagement. It is generally accepted that positive emotions linked to the discovery of a new concept support cognitive functioning, whereas stress and fear reduce analytical capacities. Fear of failure and lack of self-confidence also affect more readily learners from disadvantaged social backgrounds (Frans, 2017). Yet play, by allowing error without heavy sanction, can attenuate this fear in students who already experience it strongly.

Play also occupies an important place in development: it makes it possible to practice and develop physical, social, and cognitive skills that prepare for the demands of adult life (King & Bjorklund, 2010; Pellis & Pellis, 2007, cited in Bergeron-Boucher, 2016). Educators have drawn on this to lead children to desire what they do not desire, by building on what they already desire. In a Serious Game, the learner constantly performs actions and interactions and thus becomes the agent of their own learning. According to Brousseau (1998), the game must place the student in a situation they can live through meaningfully, in which knowledge appears as the optimal solution to the problem posed. Alvarez and Rampnoux (2016) locate the main pedagogical levers of the Serious Game in the pleasure and desire to learn, motivation, experimentation with ludic techniques, and strong learner involvement.

On a cognitive level, these devices fit with several conceptions of learning. Trial and error, inherent to gameplay, is often presented as favorable to more lasting learning. Serious Games are also part of active pedagogy, which Raucent and Vander Borght (2006) organize around three axes: learning from problem situations, learning with the help of the group, and learning with the help of a tutor. Active pedagogy fosters complex skills such as collaboration, creativity, and problem-solving.

This dynamic finally rests on the pedagogical scenario, which Louveau and Mangenot (2006) define as planning, as precise as possible, of the unfolding of a course or part of a course. Bourguignon (2008) sees in it, within the action-oriented approach, a series of communicative tasks linked to one another in order to accomplish a mission. In a Serious Game, the pedagogical objective may concern the acquisition of knowledge, a practice, or both. The quality of the scenario thus conditions what the game can actually contribute.

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3.2. Cognitive Limits and Contradictory Effects

These assets, however, do not translate mechanically into learning gains. What stimulates the student may also mobilize resources the student needs in order to learn, and this risk weighs more heavily on students with academic difficulties. Four main limitations emerge.

The first limitation is the need for scaffolding. Mandart (2019) notes that these students' reading difficulties require teacher scaffolding in order to progress in the game. Djaouti (2016) draws a more general conclusion: the mere provision of a game changes little in what students learn, and the mediation of the teacher, who thinks through the place of the game in a learning process, remains indispensable. Habgood's (2007) experiments point in the same direction: the same Serious Game is far more effective for knowledge acquisition when the teacher conducts a collective debriefing after the session.

This scaffolding takes various forms depending on the moment of the session: before the game, to present the objective and remove vocabulary or instruction obstacles; during the game, to support students who get stuck without giving them the solution; and afterward, to return to what has been learned.

The second limitation is cognitive overload. Cognitive load theory (Sweller, 1988) reminds us that working memory is limited and that any processing unrelated to the learning task draws on available resources. Yet the rich and stimulating interface of a Serious Game, which motivates the student, may divert attention from the main objective. This pitfall is particularly harmful for students with academic difficulties, whose processing and attentional capacities are often fragile, attention being itself a fluctuating resource (Maurer, 1994).

This overload can take several forms. It may stem from the multiplicity of stimuli to be processed at once (animations, sounds, scores, characters), from the complexity of the rules to be remembered, or from the dual task the player must assume, playing and learning at the same time. For a student with limited attentional resources, the risk is to retain mainly the mechanics of the game, those that allow winning, at the expense of the knowledge they were meant to carry. A student can thus succeed at a round without having mobilized the targeted knowledge, which makes success in the game a misleading indicator of learning.

The third limitation lies in the balance between play and learning. A game that is too simple, without challenge, bores; a game that is too complex discourages and leads to abandonment. The effectiveness of a Serious Game therefore depends on several balances: between ludic and pedagogical dimensions, between challenge and feasibility, and between technical means, financial means, and expectations (Alvarez & Rampnoux, 2016).

This balance is all the more delicate because the audience is heterogeneous: the same level of difficulty will be too easy for some and too difficult for others. The optimal challenge is not the same for a student whose difficulties stem from work methods and for a student who has broken with school, which points back to the profiles described earlier and suggests that difficulty settings should be adjustable student by student.

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When this balance is broken, effects may reverse. Repeated failure in the game risks reproducing, in digital form, the feeling of incompetence the student already knows in class, and the ludic dimension, far from attenuating fear of failure, may then reinforce it. These contradictory effects remind us that motivation is not a property of the game: it arises from the encounter between a device, a student, and a situation.

The fourth limitation concerns the choice of game and material constraints. For Wastiau et al. (2009) and Wix (2012), the relevance of the choice of game is the most important limit on its pedagogical use. Indeed, just as there are different theories of learning, there are behaviorist and constructivist games (Egenfeldt-Nielsen, 2006). This selection work falls to each teacher, according to the students, the objectives, and the working methods. To this are added material and logistical constraints (Wix, 2012), the resistance of institutions, the modest design budgets compared with the weight of commercial video games, and the insufficiency of research (Mandart, 2019).

3.3. The Particular Case of French Language Learning

For many Moroccan students, French is not the language spoken at home, which makes learning it a particular challenge. In this context, the arguments advanced in favor of play in language teaching take on special relevance. Weiss (2002) sees in play a particularly authentic situation of language use, and Godwin-Jones (2014) stresses immersion in an environment where the target language is used to accomplish a concrete task.

But these games very often rely on written instructions, dialogues, and texts to be read. Mandart (2019) notes that reading difficulties make teacher scaffolding indispensable for progressing in the game. One is then faced with a paradox: the tool meant to help students progress in French already presupposes a certain mastery of reading.

This paradox does not invalidate the use of Serious Games; it invites the choice of games whose instructions are brief and supported by visual or audio aids, and the provision of lexical preparation before the session.

4. Discussion: Towards an Enlightened Use of Serious Games

Serious Games are neither a panacea nor a gimmick: they are demanding tools whose effectiveness depends on precise conditions of use. Three requirements emerge from the analysis.

The first is pedagogical integration. The Serious Game does not replace the teacher, who remains necessary to give students access to concepts. It must be part of a well-constructed scenario (Bourguignon, 2008) and accompanied by systematic debriefing (Habgood, 2007, cited by Djaouti, 2016), which links the gaming experience to the targeted learning.

Concretely, this means that the teacher defines the objective of the session in advance, chooses the moment in the progression at which the game occurs, allows the time needed to get used to the interface, and articulates the session with the activities that precede and follow it.

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The second is adaptation to cognitive profiles. The heterogeneity described above requires games flexible enough to adjust to different levels and different ways of learning. Personalized pathways and graded challenges appear here as essential features.

For students with academic difficulties, this adaptation relies on several levers: short and accessible instructions, a pace the student can control, progressive difficulty levels, immediate feedback that explains what went wrong rather than simply penalizing it, and the possibility of repeating a stage without penalty.

The third is teacher training. Effective use requires understanding the underlying cognitive mechanisms and their limits, in order to identify situations where the Serious Game brings real added value compared with traditional methods.

This training should cover both technical knowledge, such as mastering the tools, and pedagogical knowledge, such as selecting a game according to explicit criteria, leading a debriefing, or observing students during play.

On a theoretical level, this article proposes a framework that relates these conditions and invites us to consider, alongside motivational dimensions, the cognitive costs of these tools, particularly in terms of attentional resources and working memory load.

The framework thus outlined articulates four dimensions: the student's profile, the characteristics of the game, the pedagogical scenario, and teacher mediation. The value of a Serious Game cannot be read in any one of them taken in isolation; it results from their alignment. A well-designed game that is poorly matched to the student's reading level, or a well-matched game that is not integrated into a sequence, will produce few effects. This reading shifts the usual question, "Do Serious Games work?", toward a more precise one: under what conditions, for which students, and with what support do they work?

In the Moroccan context, these conditions raise practical questions of equipment, of French-language resources suited to students' reading levels, and of teacher training. Modest experiments, conducted over short sequences with carefully chosen games and systematic debriefing, seem more prudent than a large-scale rollout.

This study has its limits. It rests on a critical analysis of the literature rather than a systematic review, and the youth of the field, together with the lack of robust longitudinal studies (Mandart, 2019), restricts the scope of its conclusions. Future research would benefit from examining the precise cognitive mechanisms (attention, working memory, executive functions) that Serious Games mobilize in specific populations, particularly students with academic difficulties, as well as the conditions under which they produce contradictory or even harmful effects: cognitive overload, frustration, and disengagement.

5. Conclusion

Serious Games open a promising path in addressing academic difficulties, notably in French language learning. Their capacity to generate motivation, engagement, and the pleasure of learning is an asset for students who are often demobilized. By turning error into a step in

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learning and by placing the learner at the center of the process, they offer a credible alternative to traditional pedagogies, which struggle to captivate a generation immersed in digital technology (Alvarez & Rampnoux, 2016; Beddaou, 2019).

This optimism must nevertheless remain measured. The risk of cognitive overload, the need for enhanced scaffolding, and the difficulty of adapting to heterogeneous profiles show that technology alone does not resolve learning difficulties. A poorly designed or poorly integrated game can be ineffective or even counterproductive, by diverting attention from the pedagogical objective or by generating frustration and discouragement (Djaouti, 2016; Mandart, 2019). Some studies also show situations in which Serious Games prove no more effective than other approaches (Wastiau et al., 2009; Wix, 2012).

The challenge is therefore less to choose between adoption and rejection than to learn to identify the situations in which play helps and those in which it gets in the way.

Three lessons emerge for practice. First, the choice of game must start from the learning objective and the students' profile, not from the appeal of the tool. Second, the session must be conceived as a whole, with preparation, a supported period of play, and a debriefing. Third, success in the game must not be confused with acquisition of the targeted knowledge: only verification outside the game can confirm it.

The future of Serious Games in education therefore lies not in their imposition as a miracle solution, but in their thoughtful integration, among other tools, into the practice of a trained teacher attentive to their students. It is on this condition that the Serious Game can give back the desire to learn to those who have lost it.

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