

Time as a Heuristic in Serious Games for Education

Răzvan Rughiniş

Faculty of Automatic Control and Computers, University Politehnica of Bucharest,
Splaiul Independenței 313, 060042 Bucharest, Romania

Keywords: Serious Games, Educational Games, Time, Timescapes, Time Work, Time Frames.

Abstract: The article proposes a conceptual framework for studying the organization of time in educational games. A time-focused analysis can productively examine time frames and time work in a serious game, in order to understand its timescapes of learning, and its politics of time. Games may be designed to accommodate strategies of play of variable time intensity, to assist players' time work, to support dynamics of learning, to encourage knowledge of history and foresight, and to illustrate various economies of time.

1 INTRODUCTION

This paper is written at the convergence of two topics of growing relevance. On the one hand, new communication technologies lead to *transformations in temporal experiences* – especially to feelings of time acceleration and scarcity (Wajcman, 2008); they also make possible new tools for measuring and monitoring time, planning and coordinating activities. On the second hand, there is an increasing understanding and *use of digital games as learning experience* (Prensky, 2001); (Gee, 2003). Digital games are sophisticated constructions that require time to play, make time go by faster, create new time lines, include instruments for tracking and allocating time, and, all in all, allow for a rich array of “time work” activities (Flaherty, 2003). We focus on the *time of gameplay in educational settings*: how can it be productively analyzed? How can it be designed to support learning?

Time is a rare topic in studies of educational games, particularly in engineering, because they often involve simple play strategies, do not require player coordination, and their play time (duration, timing, synchronization etc.) is regulated as a classroom activity (see for example J.M.D. Hill et al., 2003; Eagle and Barnes, 2008; Maragos and Grigoriadou, 2007; Leong et al., n.d.). Still, games with more complex strategies require time design and management. This applies to games that last longer, for voluntary games that invite players' attention outside classroom hours, as well as for learning based on social gaming, in which players'

synchronization and the constitution of longer-term communities are crucial objectives (see Hicks, 2010; Yoon et al., 2011; Whitson and Dormann, 2011). As students and instructors gradually become more sophisticated game players, complex design, with rigorous time organization, becomes an increasingly available option, possibly even required for learning impact.

We argue that *time is a useful heuristic in designing and evaluating digital games for education*. We propose a conceptual framework to guide the inquiry. We discuss “timescapes”, “time work” and “time frames” as useful analytical tools to study temporal arrangements and the politics of time in any project. We then examine the heuristic productivity of a time-focused lens in the study of educational games, and we formulate several orienting questions.

2 CONCEPTS AND QUESTIONS IN THE STUDY OF TIME ORGANIZATION

What are the merits of a “temporal gaze” (Adam, 2000), an analytical perspective focused on time? Looking at several analyses that put to work empirical evidence to theorize time, such as Adam (1990, 2000), Levine (2003), Roth et al. (2008), Too and Harvey (2009), and Mercer (2008), we can see that such a focus address two main concerns:

1) On the one hand, it supports an examination of the “timescape” (Adam, 2000; Too and Harvey,

2009) in which a phenomenon takes place. If landscapes include all elements of context that inform actions, timescapes make explicit the dimension of time. We can thus observe how some actors take into account (or ignore) possible “temporal horizons” (Hitlin and Elder, 2007) (for example: the near past, the distant future); how activities produce resources for one another through synchronization - or fail to do so, sometimes as a matter of segregation by design (Groves et al., 2011); how reflecting on the past shapes the evolution of a social practice. If we become alert to the timescape of a social activity, we can then proceed to extend it beyond taken-for-granted time borders. For example, we can pay attention to its histories, pre-histories or preparatory stages (Levine, 2003); (Adam, 2000); (Mercer, 2008), or to its post-events and various futures.

2) On the second hand, a focus on time makes us aware of the politics of time: how does a certain time organization becomes ‘normal’ and thus normative? Who are the winners and who are the losers of a particular time ordering? What happens when several forms of time organization conflict (Roth et al., 2008)? By looking into the temporal structure of an activity, we can also see how a process defined by specific temporal horizons and resources creates results that are later used as a-temporal facts (Levine, 2003); (Adam, 2000). By noticing the regular, ‘normal’ organization of time we can then ‘play with time’: we can re-do it in a surprising setup, in order to unravel unseen social arrangements, or just ‘for fun’ - as in digital games that include intricate time lines (Zagal and Mateas, 2010).

For example, educational games are vulnerable to problems introduced by divergent gaming styles. Students who dedicate long hours of play, with a power gaming orientation, become game elites – while more casual players are disadvantaged and discouraged to play. The management of time is crucial in order to balance different objectives of educational games – such as to engage players, to offer a level playing field, and to maintain convergence with course objectives. Game designers may introduce incentives to orient play strategies; still, results depend on players’ contextual ways of dealing with technological affordances and limitations.

When looking at how designers and players configure gaming experiences, another useful concept is *time work*, which Flaherty (2003) defines as “efforts to control or manipulate duration, frequency, sequence, timing, and allocation” of time

for a given activity. This concept is useful for directing our attention towards people’s agency in *making* time, in changing the timescapes that in turn contextualize their actions.

2.1 Time in Games

Time is an important concern for game designers (Tychsen and Hitchens, 2008). Gaming experiences are shaped by many calibrations of duration, rhythm, speed, synchronization, and players’ degree of control of game world time. In the field of video game research, there is a consistent thread of reflection concerning temporal organization (Zagal and Mateas, 2010); (Juil, 2004); (Tychsen and Hitchens, 2008). Of all conceptual distinctions, we have found Zagal’s and Mateas’ (2010) *classification of “time frames”* to be most useful for our research, because it facilitates the study of the relationships between a game and its social environment.

While Adam refers to rather broad time frames, such as natural, cosmic (seasons, days etc), embodied (cycles of reproduction or of cell renewal) and cultural (calendar time, clock time), Zagal and Mateas define time frames as any “set of events, along with the temporality induced by the relationships between events” (idem, p. 848). The analyst is in charge of deciding the *relevant* events that constitute a time frame. The authors differentiate four frames that they propose as being “commonly relevant” for video game analysis (p. 852). *Real world time* includes events from the player’s body and her physical world surroundings. *Gameworld time* refers to events that occur in the game world, which may be initiated by the players or not. Both real world and gameworld time can be productively analyzed in terms of cycles, durations, countdowns, and triggers (idem); relationships between the two frames shape the gaming experience. *Coordination time* includes events of player coordination, such as organizing rounds and turns. *Fictive time* is the set of references that link various game events to culturally-defined labels, derived from historical or fictional stories.

The advantage of this conceptualization is that other frames can be developed to include subsets of events that are relevant for a given analysis. Zagal and Mateas illustrate this by introducing the *interface frame* as the “set of events that take place in the game’s user interface” (idem, p. 860). We can see that the interface frame groups events included in gameworld time; still, it is a heuristically powerful concept because it helps us observe what

particular moments of gameplay are emphasized, and how players' actions are sensorially formulated and published, with consequences on players' decision context and feedback, reputations, and their resulting motivation to engage with the game.

From this perspective, we see that time work can include not only the control of the temporal properties (duration, frequency etc.) *within* a given time frame, but also the *management of multiple time frames* (inter-relating them, pushing them to the fore or background of decision-making), and the *creation of novel time frames* through which to experience or to observe time.

For example, designers of serious games may introduce *metagaming time frames*, by creating social events in which game and gameplay are discussed and reflected upon. Such events – focus group meetings, peer content generation, social gatherings involving players and designers, social web technologies (Trăușan-Matu et al., 2009) – would constitute a distinctive time frame, producing and organizing learning through reflexive gaming.

Another way of using time frames in order to adjust serious games to learning contexts consists in the configuration of the interface frame. In order to encourage a variety of play styles, a game may be internally diversified, through a looser focus on total game scores, and a more prominent role for diverse achievements. Players' status in the gameworld is dependent on their opportunities for self-presentation. An interface that brings to the fore the total game score, in which game progress is measured by quantitative changes in one's overall rank, stimulates competition, but may discourage participation at the margins of the ranking. An interface that captures and displays temporary successes, through achievements or other mentions, without melting them into a unified metric, may afford a more diverse player engagement, tolerant with uneven rhythms of gaming.

2.2 Time as a Heuristic in the Study of Educational Games

Challenges for the organization of time in games are to a large extent game-specific; there are, still, some issues of common relevance, concerning *player engagement*. Games that are used in learning projects pose additional, specific challenges. Some derive from managing *learning as a temporal process*; others refer to the timescape of the *subject matter*. An overview of these three layers of challenges is presented in Table 1; we discuss each of them below.

2.2.1 Game Time and Player Engagement

Firstly, a shared objective of games consists in *motivating* and enabling potential players *to make time for actual game play*: that is, motivating newcomers to enter the game at later times, and motivating a diversity of older players to keep on playing. We use Yee's classification of three motivational drives in gameplay, namely achievement, social life, and immersion (Yee, 2006), to discuss specific challenges:

- As regards *achievement*, a difficulty consists in loosening the strong coupling of game performance to time consumption (Steinkuehler, 2006). This uncoupling can be pursued by introducing multiple (qualitative) types of accomplishments, corresponding to different (quantitative) levels of time investment. It can also be realized by using various time metrics (duration, speed, coordination, prediction etc.) to define performance.
- As regards *social life*, common challenges in the organization of game time include: 1. supporting in-game socializing by synchronous, joint play; 2. supporting asynchronous interaction between players; 3. the creation of rich characters that display their in-game biographies and reputations.
- As regards *immersion*, it is also dependent on the temporality of game play. A game can facilitate engagement by: 1) a *fictive time frame* that supports the vividness of the game world and characters (Zagal and Mateas, 2010); 2) balancing the *speed* of game events and players' skills to maintain the flow of play (Chen, 2007); 3) managing "*dead time*" (including waiting, or character grind time) (Juul, 2004), (Van Meurs, 2011); players may also deal with dead time through rule-bending (Consalvo, 2009) that affects other players' motivation.

Secondly, games may also provide means to assist players in their time work, including the effort of converting real world time into play time. Games may support players by a variety of options and tools: the possibility of achieving noteworthy results in short lapses of engagement, accessibility on mobile devices, tools for monitoring time indicators during play (speed, duration, countdown etc.), tools for monitoring the gameworld while not playing, reminders, and so on.

Thirdly, game designers may consider engaging players in the evaluation of the game and the construction of future editions, thus articulating the game history with players' biographies.

Table 1: A time-focused perspective on educational games.

Topics		Game timescapes	Game politics of time
All games	1. Time in games	<ol style="list-style-type: none"> 1. Motivating players: uncoupling achievement from time consumption; supporting socialization and in-game biographies; creating a gameworld with a distinctive experience of time; 2. Supporting players' time work; 3. Engaging players in the game evolution; 	<ol style="list-style-type: none"> 1. What sort of time work is required to become part of the game elite? Who are the 'top players'? 2. What sort of time work is required to participate in the game evolution? Who participates?
	2. Time in the process of learning	<ol style="list-style-type: none"> 1. Influencing the quantity of time, for game and non-game learning; 2. Influencing the quality of time, for game and non-game learning; 3. Shaping the time allocation and sequence of learning activities: exploration, study, practice, repetition, out-of-the-box connections, meta-communication; 	<ol style="list-style-type: none"> 1. What values are embedded in the game and non-game activities of learning? 2. How does the game modify the relationships in the learning project (between students, and between instructors and students)? 3. How is the game elite related to the elite of non-game learning activities? What powers accrue to each status?
Educational games	3. Time in the learned-about world	<ol style="list-style-type: none"> 1. Learning histories; 2. Learning various economies of time. 	<ol style="list-style-type: none"> 1. What note-worthy events and persons are highlighted to narrate a history? 2. What selected economies of time are introduced?

2.2.2 Time in the Process of Learning

Learning unfolds in time, and it is about topics that take place in time. If we think of learning as a process of mastering a novel symbolic (and material) world, then we can distinguish the time created by this process itself, and the time included as a dimension of the world under study. We can then ask two questions:

On the one hand, how does play time influence the time of the process of learning (in play and non-play activities)? On the second hand, how does the game influence the time of the learned-about world?

As regards the first question, there are at least four ways in which games are relevant:

1. Play time *changes the quantity of learning time*, by displacing other activities. Given that games are usually associated with leisure, an educational game can be used to push learning activities in time zones which would otherwise not be formally available, such as holidays or night hours;
2. Play time *changes the quality of learning time*, in both play and non-play activities. Gameplay has the potential to re-define non-game activities in the learning project, for example by making them seem rather boring, or, alternatively, by giving them new meaning, by association with game-created information or social networks;

3. Play time *changes the time allocation and sequence* of various learning activities, such as exploration, study, repetition, practice, out-of-the-box thinking (for example, with metaphors and analogies), meta-communication and learning about learning (Bateson, 1972);

4. Last but not least, the game *introduces a different economy of time*: time investment in the game leads to other benefits than in the non-game activities. Educational games may cultivate players' understanding of time economies, by design. Games also have distinctive criteria for performance, and creates their own elite, which is related to the game's time politics (as a rule, players that spend more time in the game tend to obtain higher scores). Since in educational games fairness is an important concern, designers often attend to time organization in order to level the playing field.

2.2.3 Time in the Learned-about World

The game may introduce *histories* of the subject-matter as a topic of learning. These histories can furnish the game's fictive time, or they can be present through various game elements: characters, quizzes or riddles, side-line stories etc. The game may also familiarize students with multiple economies of time existent in the studied domain: the times of scientific research, of company-based

production, of open source development, of possibly related fields such as medicine, the military, politics etc.

2.2.4 An Illustration: World of USO

This article was written as a reflection on the serious game “World of USO” (WoUSO), developed since 2007 in the Computer Science Department of University POLITEHNICA of Bucharest to accompany a course on Using Operating Systems (USO). The game is presented in detail in Rughiniş (2012); for the purpose of this article we should note that it serves as an accompanying activity for the USO course, aiming to stimulate student sociability around CS topics, and to foster a playful orientation in technical work and learning. WoUSO is an open source project, in which students and former players are invited to participate; each academic year the game lasts throughout the first semester, until the course ends. The game is complex, including several activities; its main components are: Question of the Day (QotD), a daily quiz question from the course curriculum; Weekly Quests, sets of riddles on general technical and CS culture topics, with a whimsical outlook; daily Duels in which students challenge one another and compete by answering sets of 5 quiz questions from the course curriculum, in 5-minute asynchronous sessions; Spells used to modify actions and outcomes for oneself and for one’s opponents (increasing or decreasing rewards, hiding real scores, paralyzing actions etc.). Each game activity generates points that accumulate in the players final score; at the end of the semester, the Top 10 players are declared the winners, and the first player receives the WoUSO cup.

We have noticed that time organization in WoUSO had unexpected effects. Although each activity opens a different temporality (rhythm, schedule, duration etc.), by cumulating all points in an overall score the score-display interface frame became dominant. This frame was defined by the linear time of score growth, mainly through duels. Players who, for some reasons, did not play duels for a while fell rapidly behind in rank, and felt discouraged to re-enter the game: the linear time of score-display dominated the cyclic temporalities of the Weekly Quests, which invited players for a new adventure every week. Virtually all players but the top 20 ones, with approximation, who played competitively in order to win, were actually dissuaded in later weeks to convert realworld time into gameworld time. The game elite was finally determined through willingness to persistently invest

considerable time in duels, all along the semester; time allocation was central in WoUSO politics. Moreover, since game difficulty increased along the semester, and so did the difficulty of course-related work, this led to time work conflicts between the “student” and the “player” roles, further encouraging “power players”. Since, as a rule, game winners became members of the development team for the next semester edition, the game development timescape inadvertently privileged, in design options, the “power player” style of time work.

In order to encourage a broader and more diverse student participation throughout the game, in the 2012 edition developers have changed the game interface to display more prominently distinctive scores for Weekly Quests and Duels, and have also introduced achievements to reward diverse time work strategies, such as persistence in playing, early or late hours of play. Since duels have continued to dominate the game and to structure players’ time work in this semester too, planned new developments for the next edition, in the Fall of 2013, include: the classification of players into named levels (‘leagues’) to encourage players in the lower ranks to engage one another in duels; a Grand Challenge in which all players participate through random duels; changes in scoring to raise the importance of the Weekly Quest.

We have also consolidated the metagame time frame by introducing a face-to-face mid-term encounter between players (students) and developers (former players and faculty), which has encouraged collegiality and has led to useful insights into actual gameplay and possible improvements.

3 CONCLUSIONS

In this paper we argue that time is a useful analytical lens in examining educational games, and we propose a conceptual framework to guide inquiries.

By analyzing the organization of *time frames* in a game, and its support for players’ *time work*, we can pursue two directions of investigation:

- The study of timescapes: the ensemble of time structures and practices that inform decision-making and social action;
- The study of the politics of time: how certain time arrangements become normal, how they support specific definitions of performance, and create reputations and elites.

The study of time in an educational game profits from its examination on *three layers*: 1) time and player engagement, 2) the organization of time in the

process or learning, and 3) the time organization of the subject matter.

REFERENCES

- Adam, B., 2000. The Temporal Gaze: the Challenge for Social Theory in the Context of GM Food. *British Journal of Sociology*, 51(1), pp.125–142.
- Adam, B., 1990. *Time and Social Theory*, Polity. Cambridge.
- Bateson, G., 1972. *Steps to an Ecology of Mind*, Ballantine Books. New York.
- Chen, J., 2007. Flow in Games (and Everything Else). *Communications of the ACM*, 50(4), p.31.
- Consalvo, M., 2009. There is No Magic Circle. *Games and Culture*, 4(4), pp.408–417.
- Eagle, M. & Barnes, T., 2008. Wu's castle: teaching arrays and loops in a game. In *SIGCSE Bull. ACM*, pp. 245–249.
- Flaherty, M. G., 2003. Time Work: Customizing Temporal Experience. *Social Psychology Quarterly*, 66(1), pp.17–33.
- Gee, J.P. 2003., *What Video Games have to Teach Us about Learning and Literacy*. Palgrave Macmillan. New York, NY.
- Groves, J. M., Ho, W.-Y. & Siu, K., 2011. Youth Studies and Timescapes: Insights From an Ethnographic Study of “Young Night Drifters” in Hong Kong’s Public Housing Estates. *Youth & Society*, Online, pp.1–19.
- Hicks, A., 2010. Towards social gaming methods for improving game-based computer science education. In *Proceedings of the Fifth International Conference on the Foundations of Digital Games FDG 10*, pp.259–261.
- Hill, J. M. D. et al., 2003. Puzzles and games: addressing different learning styles in teaching operating systems concepts. *SIGCSE Bull.*, 35(1), pp.182–186.
- Himanen, P., 2001. *The Hacker Ethic and the Spirit of the Information Age*, Random House. New York.
- Hitlin, S. & Elder, G. H., 2007. Time, Self, and the Curiously Abstract Concept of Agency. *Sociological Theory*, 25(2), pp.170–191.
- Juul, J., 2004. *Introduction to Game Time*, MIT Press. Available at: <http://www.electronicbookreview.com/thread/firstperson/teleport>.
- Leong, B., Koh, Z. H. & Razeen, A., s.a. *Teaching Introductory Programming as an Online Game*. Available at: <http://www.comp.nus.edu.sg/~bleong/teaching/teaching-online-game.pdf> [Accessed June 20, 2012].
- Levine, M. R., 2003. Times, Theories and Practices in Social Psychology. *Theory & Psychology*, 13(1), pp.53–72.
- Levy, S., 1984. *Hackers, Heroes of the Computer Revolution*, Anchor Press / Doubleday. Garden City, NY.
- Maragos, K. & Grigoriadou, M., 2007. Designing an Educational Online Multiplayer Game for Learning Programming. In *Informatics Education Europe II Conference*. SEERC, pp. 322–331.
- Mercer, N., 2008. The Seeds of Time: Why Classroom Dialogue Needs a Temporal Analysis. *Journal of the Learning Sciences*, 17(1), pp.33–59.
- Prensky, M., 2001. *Digital game-based learning*, McGraw-Hill. New York.
- Rughiniş, R., 2012. *Serious Games as Input versus Modulation: Different Evaluations of Utility*. In *Proceedings of the BCS HCI 2012, BISL*, pp. 175–184.
- Roth, W.-M., Tobin, K. & Ritchie, S. M., 2008. Time and Temporality as Mediators of Science Learning. *Science Education*, 92(1), pp.115–140.
- Steinkuehler, C., 2006. The Mangle of Play. *Games and Culture*, 1(3), pp.199–213.
- Too, L. & Harvey, M., 2009. Accommodating “Accelerating” Time: The Use of Timescapes in Corporate Real Estate Strategies. *Journal of Corporate Real Estate*, 11(3), pp.158–168.
- Trăuşan-Matu, Ş., Posea, V., Rebedea, T., and Chiru, C., 2009. Using the Social Web to Supplement Classical Learning. *Advances in Web-Based Learning – ICWL 2009*, 5686: 386–389.
- Tychsen, A. & Hitchens, M., 2008. Game Time: Modeling and Analyzing Time in Multiplayer and Massively Multiplayer Games. *Games and Culture*, 4(2), pp.170–201.
- Van Meurs, R., 2011. And Then You Wait: The Issue of Dead Time in Social Network Games. In *Think Design Play DiGRA Conference*. Utrecht School of the Arts, pp. 1–12.
- Wajcman, J., 2008. Life in the fast lane? Towards a sociology of technology and time. *The British journal of sociology*, 59(1), pp.59–77.
- Whitson, J. R. & Dormann, C., 2011. Social gaming for change: Facebook unleashed. *First Monday*, 16(10). Available at: <http://firstmonday.org/>.
- Yee, N., 2006. Motivations for Play in Online Games. *Cyberpsychology and Behavior*, 9(6), pp.772–775.
- Yoon, I. et al., 2011. Educational Multiuser Online Game: “debugger” game for Introductory Computer Science Class. Available at: <http://world-comp.org/p2011/FEC4464.pdf> [Accessed June 14, 2012].
- Zagal, J. P. & Mateas, M., 2010. Time in Video Games: A Survey and Analysis. *Simulation & Gaming*, 41(6), pp.844–868.