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Abstract. Games and/or play are often used in educational context as mediation. The resulting teaching or training activitys are however difficult to assess. To set up a model to allow evaluating these activitys, we choose to enrich an existing grid, that was developed in 2006 by Sara de Freitas and Martin Oliver, centered on pedagogical considerations. We propose to add dimensions relating to the game, the humans involved, and their interactions with the game. The resulting grid takes into account COntext, LEarner, Course scenario, Teacher, plaY aNd Game, making the Colectyng framework.
The model was then confronted to literature to see if we could complete the grid and whether all elements could fit in the model, assuming that the collecting framework would act as a meta-model. Altogether our analysis suggest that the colectyng framework indeed acts as a meta-model that could give a general view and could facilitate the articulation between more specialized models.

Game-based learning Evaluation

1 Introduction

Game Based Learning (GBL) is a controversial subject, sometimes presented as very promising [37, 15, 31, 12] or hindered by significant defaults [25, 32]. It is therefore crucial to have a rigorous/agnostic framework to evaluate game-based learning activities and tools. As noted by Tahir and Wang it is not the case yet: "most studies focused only on one or two dimensions of GBL and very few focused on overall evaluation specifying all the dimension essential for GBL evaluation, highlighting the need for a comprehensive evaluation framework" [35]. Noteworthy, De Freitas and Olivier created a grid comprising four dimensions to help tutors assess the relevance of educational games and simulators within the context of formal teaching activities [11]. We present a new model based on

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the work of De Freitas and Olivier, and the addition of new parameters to be taken into account, the Colectyng framework.
In fine, the framework should be as exhaustive as possible to allow better design and evaluation of game-based learning activities. Therefore, this model is confronted to the literature to test whether it allows to take into account all the parameters that have been identified to affect game-based learning activities. **The underlying hypothesis is that colectyng is a form of meta-model.** It is therefore expected that: i) taking into account new data will allow to fill the grid; ii) no element will fall outside of the grid; iii) Models describing details could be encapsulated in the grid without the depth of specialized models. We will therefore, in the next sections of the manuscript: i) present the framework in section 2, ii) then compare its elements with elements with other studies in section 3, in order to test its exhaustive character.

2 Positioning and development of an enriched model

Such a framework has been proposed as the CEPAJe model[2]. Unfortunately, it has not been tested exhaustively and it is available only in French, so we propose a brief presentation in this section.

2.1 De Freitas and Oliver's evaluation grid

Most models related to GBL and Digital Game Based Learning (DGBL) focus essentially on the game design process on the line of the DGBL history educational games design model [41]. This involves developing each game by iterations taking into account feedbacks from play testing. However, once the game is finished, these models do not really make reference to the way of using it. Other models endeavour to assess finalized software with educational objectives [30, 9, 21]. But games or edugames are not actually identified within the corpora being studied. It is more a question of incorporating all the software programmes and technologies designed to educate, including purely utilitarian applications. Whereas, in the work being conducted by us, the play mediation is central. Thus, to our knowledge, one of the rare models that attempts to assess the use of DGBL within a teaching context seems to be that of Sara de Freitas and Martin Oliver[11] that considers four criteria: Context, Learner specification, Pedagogic considerations, Mode of representation (Tools for use).

2.2 Taking the trainer into account

This model offers an association between the tool and the human aspect. However, neither trainer, teacher, support teacher, tutor nor educator are included. This is a lack in our opinion. Indeed, teachers play a key role in the manner in which a play activity is introduced within the lesson and the debriefing is carried out once the activity has ended[33]. This point is confirmed by De Freitas and Oliver themselves in the core of their article (De Freitas and Oliver, 2006). The

teacher must also, in our point of view, be responsible for the link between the teaching dimension, the game and the player throughout the entire activity. A new dimension was therefore proposed for the trainer.

2.3 Adding a second dimension

A second entry was added to take into account the key stages in the activity, namely the brief, activity animation and debriefing. Horizontally, we have positioned the assessment criteria in relation to these key stages. The resulting model, enables the aspects presented above to be taken into account[2]. We name this model: COntext, LEarner, Course scenario, Teacher, plaY aNd Game or "Colectyng grid". The resulting grid is presented in Figure 1.

Criteria / Dimensions	Game culture	Play skills	Introduction to the activity	Carrying out the activity	Debriefing the activity
Context (1 Context)	–	–	Does the place affect this phase of the activity?	Does the place affect this phase of the activity?	Does the place affect this phase of the activity?
Trainer (New dimension)	History, resources, markets, vocabulary...	Play skills patterns understanding	Ability to engage students in the game activity	Ability to help students during the game activity	Ability to link game with learning outcomes
Learner/Play (2- Learner specifications)	History, resources, markets, vocabulary...	Play skills patterns understanding	Will to enter in the gaming activity	Ability to use and read the game	Ability to take distance from the game
Pedagogy (3- Pedagogic considerations)	–	–	Games integrated in didactic scenario. Learning objectives?	The scenario takes game limitations into account	The scenario anticipates transfer
Game (4- Mode of representation)	–	–	mapping of games elements vs learning objectives	The game proposes help and accessibility tools	The games gives feedback on players accomplishments.

Fig. 1. Initial CEPAJe model[2]

3 Exploring the grid

We explore here the possibility to fill the grid, i.e. do empty boxes in table 1 correspond to known situations? We also try to see if the framework is exhaustive, i.e. if there are known situations that do not fit in the framework.

3.1 The Context

To illustrate the importance of the context, and its representation in the framework we will ground our analysis on the work of De Freitas [10].

Game culture As noted by De Freitas, "the use of game-based learning can change not just what is learnt but also significantly how we learn, for this reason it is important to consider all the possible implications of adopting game-based learning in your practice such as context of use, duration of study periods, technical support, community of practitioners."[10]. The experience of the organization with games and game-based learning will therefore impact the activity.

Play skills De Freitas also noted that game-based learning involves "greater flexibility not least in terms of learning session durations, assessment modes and accreditation"[10]. We therefore add 'Technical context' to the 'Play skill' column to illustrate the influence of the context on the play potential.

3.2 The trainer

Even though the teacher is not required to play the games, s.he must guide play during the activity and provide support for learners. All this requires skills from the teacher in introducing the game, guiding it, playing if required, helping learners to play and finally, debriefing the game. According to their ability to fulfill these tasks, the activity will be successful to a greater or lesser extent. The experience of players with games is far from obvious [34], and therefore needs to be taken into account. In parallel, the teacher must ensure there is a connection with the 'educational scenario'. This implies a specific skill as the successful association is not easy: 'The constraints linked to learning (acquisition of skills, practice, assessment) and the play features (action, emotion, commitment, attractiveness) must be mixed in the correct proportions to stimulate the desire to learn and thus incite students to work on their own.' [26].

The trainer play skills and game culture. The (lack of) play skills and game culture has been cited as one of the main reasons to not use games in education [32]. The main reason might be that it is required to allow a proper use of the game [32]: "The physics teacher wishing to use computer games as a reservoir of examples —inertia, trajectory, conservation of momentum, gravity, velocity, and so forth— would do well to know, for instance, the calculable differences to be found among hand-drawn, pre-rendered, and real-time rendered game scenes.". The lack of games skills might also push some teachers to modify their teaching scenario, [32]: "This explains why many teachers who claim to teach with computer games actually teach with video recordings of game play, pre-captured and predictable simulacra of gaming.". Finally, teaching with games imposes constrains that need to be understood[32]: "teaching with computer games requires certain commitments and concessions by both teacher and student, the most important of which is a willingness to accept the historical and continuing complexity of the medium.". The trainer playskills are therefore important.

The trainer's ability to engage students. The narrative is an important aspect in many games [19]. This is also true for serious games: "Stories are equally important for serious and non-serious games alike." and "While we cannot always control the actions of the player or the way he plays the game, we can adjust our storytelling technique to better align our learning objectives with our dramatic objectives." [28]. This observation underlines the role of the teacher in introducing the game, and engage students before and during the game. Furthermore, the trainer will have to make the connection between what happens in the game and the learning goals. We suggest that the ability of trainers to do so will depend in part of teacher's game culture.

3.3 The Learner

A playing learner. Without a player, the game study is restrictive, as a given game can have different signification for different players [20]. The enjoyment of e-learning games, or flow, can be considered as shown by the EGameFlow scale [14]. This model identified several factors (Concentration, Goal clarity, Feedback, Challenge, Autonomy, Immersion, Social interaction and knowledge improvement) as key parameters. We therefore propose to add these elements to the learner dimension. The relevance of these parameters has been further validated with the EduFlow model [18].

Learner's play skills. The experience of a 'game' used for learning can be dramatically modified by a participant previous play experience as noticed by Lydia Martin [27]: i.e. a skilled player can find room for play where others will not. In addition, the possibilities inside the game will depends on their experience as noticed by Linderoth using the concept of affordance (possibilities offered to the player)[25]: "An expert gamer is, according to this ecological approach, someone with the capability of perceiving more affordances in a gaming situation than more casual gamers or non-gamers." The game itself might also modulate this situation: "Learning in a game situation becomes first and foremost a question of becoming capable of perceiving affordances and developing skills that are necessary in order to utilize these affordances." We therefore propose to add learner playskills as an important item.

3.4 The Pedagogy

Pedagogical context involves the Briefing, the play and the debriefing. In addition, games representation might refrain players from entering the activity, in particular commercial games, as noted by Ruggill [32]: "Making commercial computer games part of the classroom experience challenges the work/play separation because for many students the division of leisure from labor is precisely what makes work time endurable".

Pedagogical objectives. Defining the pedagogical aim is of course a prerequisite before the creation of a serious game [5]. More broadly, there needs to be a connection between the game mechanics and pedagogy [4]. Furthermore, the pedagogical objective will also have to be presented in the briefing and tested after the activity. In addition the use of the games might require adaptation from the teacher possible only if the game can be altered.

Acquired skills The work of Vincent Berry, have made a study of the skills developed by gamers of MMORPG (Massively Multiplayer Online Role Playing Games) regarding their fine dexterity and their aptitude for carrying out several tasks simultaneously [8]. Playing arcade video games such as Tetris (Pajinov, 1984) and First Person Shooter (FPS) games like Medal of Honor (EA, 1999) is also associated with learning and increasing performance by the people who enjoy playing them. Thus, as shown by C. Shawn Green and Daphné Bavelier, playing these types of games may modify a whole section of visual abilities linked to attention [17]. It therefore appears pertinent to open up the model to

encompass all games. As a consequence, skills developed by the game need to be studied.

3.5 The Game

In term of **context**, a question that should be asked is who produced the game, as this might raise ethical issues[23].

Game genre The game genre can have an impact on pedagogical considerations. Indeed, a game that has a sandbox mode would allow a teacher to design an exercise. We therefore propose to alter the game culture entry to take into account the game genre. That allows to create an intersection between the game and trainer/learner/pedagogy.

Accessibility The serious goal implies that the game needs to be adapted to everyone, including non-gamers, which in turn implies to use accessible games. The entry barrier of games should be low and their difficulty adapted to each player [24]. They should provide appropriate challenges so that the player's skill level can be easily matched by varying the level of difficulty [14]. The player may have difficulties in interacting with the game, in case of disability for instance [39, 40]. The game should be evaluated for its accessibility [7]. The design of views can be more or less inclusive [29]. The controllers can also be more or less intuitive [3]. Several channels can be used in parallel, not only the visual one, to convey important information. Indeed, sound effects and music can drive interest or increase scenario effects, but can also convey some information through sound rather than visual effects (e.g. score progress) [6].

3.6 Literature analysis

This section explores the grid in the light of relevant papers. Articles were identified in a literature survey looking for "game-based learning" and (framework or model). The following articles were selected after abstract review:

All, et al. 2015.enj The study by All and collaborators is centered on assessing the effectiveness of digital game-based learning [1]. One crucial aspect of the study is therefore the evaluation of learning outcomes. Learning outcomes, and their evaluation, is not present in initial model but can easily be added in the pedagogy line.

Kiili, 2005. Kiili focuses on flow [22] which corresponds to the learner/play line. The study identifies three times: Flow antecedents, Flow experience and Flow consequences that correspond to the Introduction, Carrying the activity and debrief stages in colectyng. The term antecedent is however larger than just the introduction phase and encompass aspect that have been proposed above. We therefore adopt the name 'Antecedent' for the second column. Interestingly Flow antecedent has three poles (Person/Task/Artefact) that correspond to intersection between game and learner/play and points to the need to add connection between boxes (see below).

Gosper, et al. 2012. The MAPLET framework analyses the alignment between learning outcomes, students' expertise and assessment methods [16].

The elements of the framework are: Students' expertise, Aims/outcomes, Processes, activities and Assessment. Each element can be placed in the Colectyng grid. Students' expertise finds its place at the Learner/ Antecedent intersection. Aim/outcomes are already present but would rather fit under the antecedent category. Processes and activities correspond to the column devoted to the activity, respectively in the Pedagogy and Game lines. The assessment is already present at the intersection of Pedagogy and Debriefing.

Tan, et al. 2007. The "Adaptive digital game-based learning framework" proposes design principles for game-based learning [36]. The framework explores two dimensions, learner and game design, that fit easily the learner and game dimensions of the colectyng framework. For the learner the dimension two essential aspects identified are psychological needs and cognitive development, that match the students' expertise added above. In addition, learning behaviors is proposed as a significant factor which fits with the flow factors. The game design dimension corresponds to the intersection of the Game line and the activity column. The task corresponds to the activity added above, whereas, feedback and narration could be added at that level.

Foster 2012.. The study by Foster combines two elements, the TPACK and PCaRD framework and methodology [13]. The idea of combining two models is congruent with the notion of a meta-model coordinating more specialized models. The TPACK framework take notably into account the Technological, pedagogical and content knowledge, which corresponds to the antecedent for the learner. The PCaRD model considers the link of the game with the learning outcomes, the role of the debriefing, including reflection and discussion, and the influence of the context, which are all present in the grid. Several aspects of the study can be added to the grid: the game genre and it's relation to the pedagogy, player type and the reflection and discussion steps of the debriefing.

Van Staalduinen, et al. 2011. The study by van Staalduinen and de Freitas brings together three frameworks to create a new one, again in agreement with the notion of a meta-model [38]. In their proposed framework, the main elements are: i) the pedagogy (background, learning objectives, instructional design, assessment and alignment), ii) users behavior and system feedback, iii) gameplay and player motivation/flow. All of those aspects are already present in the colectyng framework.

4 Summary and proposal for an enriched model

Let us now assess our various analyses in view of enriching the model of De Freitas and Oliver. By starting out with De Freitas and Oliver's model, and by taking into account the various suggestions, we obtain the enriched model recorded in Table 2. The original four dimensions of De Freitas and Oliver have now been enriched with a new dimension regarding the Trainer. These five dimensions, renamed Context, Trainer, Learner, Didactic Scenario and Game, have been set out vertically in the table of our enriched model. We have then looked for for other models/frameworks to see if we could complete the grid and whether all

elements could fit in the model. Assuming that the collecting framework would act as a meta-model. We found indeed that it was possible to reach a much more complete framework (compare Table 1 and 2). We note however that to reach that goal we had to change names and that our literature review was not exhaustive. Thus, although we might thus have missed exceptions, altogether our analysis suggest that the colectyng framework indeed acts as a meta-model that could give a general view and could facilitate the articulation between more specialized models.

Criteria / Dimensions	Game culture Game genre ludopedagogic alignment	Antecedent Technical aspects Abilities, Play skills	Introduction to the activity	Carrying out the activity	Debriefing the activity
Context (1 Context) **Trainer** (New dimension) **Learner/Play** (2- Learner specifications) **Pedagogy** (3- Pedagogic considerations) **Game** (4- Mode of representation)	Organization game culture History, resources, markets, vocabulary... History, resources, markets, vocabulary... Player type Does the game allow for content creation? Who produced the game? Game genre (-> pedagogy)	Technical context (cost, material, time, etc) Ability to read patterns Ability to read patterns Student expertise Learning objectives? Do special need learner need accommodation? Adapted to all players? Accessibility /scaffolding	Does the place affect this phase of the activity? Ability to engage students in the game activity Will to enter in the gaming activity Games integrated in didactic scenario. mapping of games elements vs learning objectives	Does the place affect this phase of the activity? Ability to help students during the game activity Ability to use and read the game Flow factors Processes (->activities). Game limitations considered Activities (-> Processes) The game proposes help and accessibility tools	Does the context affect this phase of the activity? Ability to link game with learning outcomes Ability to take distance from the game Reflection, discussion The scenario anticipates transfer Assessment The games gives feedback on players accomplishments.

Fig. 2. The Colectyng framework

5 Conclusion

In an educational context where play is chosen as mediation, providing appropriate types of support seems important to us. To do this, we began by drawing up a first model aiming to assess the initial teaching or training activity using play as mediation. We used the grid drawn up by De Freitas and Oliver in 2006 as the initial framework. Once enriched, the grid gives a first version of the Colectyng framework. In future work, we will test the Colectyng model with teachers and trainers to verify its relevance but also the possibility of making concrete use of the meta-model in classroom or training centers.

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