Serious Games in Formal Education: Discussing Some Critical Aspects

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Abstract: Innovation in technology together with evolution in pedagogical approaches is encouraging increased integration of technology-supported interventions in mainstream teaching practices. One area attracting particularly close attention in this respect is Serious Games (SGs), which offer considerable potential for facilitating both formal and informal learning experiences in supported and standalone contexts.
Advances in technology and in technology enhanced learning are raising learners' expectations for immersive and engaging game-based experiences. This trend is underpinned by the emergence of young learners adept at using digital technologies and the internet; there is an attendant risk that, as students, they may be alienated by traditional education and its failure to engage them fully in a lifelong learning process and prepare them adequately for the challenges of the 21st Century.
SGs would appear to offer an attractive solution in this regard. However, there are a number of inhibitors preventing their wider take-up in mainstream education, with the result that the considerable potential on offer has yet to be fully exploited. This situation is the background for the joint efforts of partners in the Games and Learning Alliance (GALA), an EC-funded Network of Excellence on SGs, especially the sub-group dedicated to the pedagogical dimension of SGs. In its discussions on the key challenges for more wide-scale and effective SG use, the group has focused in particular on aspects related to the central role played by the educator in formal education settings. Specifically, discussion has focused on the challenges posed when educators are called on to modify their practice, adopting the new roles and approaches demanded for effective SG deployment.
This paper presents the outcome of the group's exploration. It frames the question of the educator's central role by drawing on research work that, in the view of the different authors, embodies the major references for shedding light on this multi-faceted aspect. As well as the new role that the educator assumes in games-based learning environments, particular attention is also dedicated to the innovative pedagogical approaches that can be applied to SG deployment, especially those inspired by peer collaboration.

Keywords/Key Phrases: game-based learning, serious games, pedagogical issues, formal learning.

1. A glance at Serious Games deployment for educational purposes

Over recent years considerable interest has been devoted to the pursuit of learning through, and with, digital games and particularly so-called Serious Games, namely games that "support learning in its broadest sense" (Stone 2008). Many studies have pointed to the positive qualities of Serious Games (SG), such as their persuasiveness and motivational appeal, which can support immersive, situated and learner centred learning experiences. Proponents of SGs see them as a means for active construction, rather than passive reception, of knowledge and as prime opportunities to practice the kind of soft skills considered crucial in the knowledge society, such as problem-solving, decision-making, inquiry, multitasking, collaboration, creativity (David & Watson 2011; Gee 2003; Aldrich 2009). While some detractors remain skeptical (Foster, Mishra & Kohler 2010), most agree that they

do have potential for learning, although there are inhibitors to uptake in formal education (Williamson 2009; Sandford et al. 2006; BECTA 2005).
Further support for the validity of games-based learning approaches can be drawn from correspondence with established learning theories such as those proposed by Gagne. Each of his five categories of learning (verbal information, intellectual skills, cognitive strategies, motor skills, attitudes) finds a strong connection with SGs. Furthermore, his well-known "Nine Events of Instruction" are ideally suited to learning with SGs (Van Eck 2010).
While games cannot be considered the panacea for all educational situations, they may offer a new instructional technology with great potential (Gibson 2006). Much of this potential is identified in the effective manner in which SGs engage users, transforming them into proficient and ultimately successful (winning) players. In this sense games succeed precisely by employing effective pedagogical approaches such as situated cognition, cognitive disequilibrium, and scaffolding to teach *what* is needed, *when* it's needed without compromising the essential fun factor that ultimately lies at the heart of any game's success (Van Eck 2010; Bopp, 2006). Over the last few years the focus of SG-oriented research work has concentrated on how to strike a successful balance between game playability and instructional design. These efforts have given rise to models and frameworks such as the four dimensional framework (de Freitas & Oliver 2006), the exploratory learning model (de Freitas & Neumann 2009), multimodal interface architecture model (White et al. 2007; Arnab et al. in submission) and the game-based learning framework (Van Staalduinen & de Freitas 2010).
In particular the four dimensional framework (fig 1) advocates the use of pedagogy, an emphasis upon learner modelling, the required amounts of fidelity, interactivity and immersion in the representation of the game, and consideration of the context within which learning takes place (Rebolledo-Mendez et al. 2009; de Freitas & Jarvis 2008). Each of these four dimensions encompasses aspects that are essential not only for game design and evaluation but also for effective adoption in educational processes. Learning specification involves elicitation of the characteristics defining the learner population so that the intervention can be tailored to meet requirements and optimise outcomes. Representation regards key attributes of SGs such as immersion and interactivity which, when successfully implemented, can open the way to the sorts of flow-driven learning experiences recognised as being among the chief potentials of game based learning (Csikszentmihalyi, 1990). Context is a key consideration in technology enhanced learning generally; as discussed in the following section, context plays a particularly important role in shaping learner expectations as far as SGs are concerned. Pedagogic considerations represent the cornerstone of any instructional intervention, encompassing models and approaches (e.g. associative, cognitive, situative) adopted in pursuit of learning objectives.

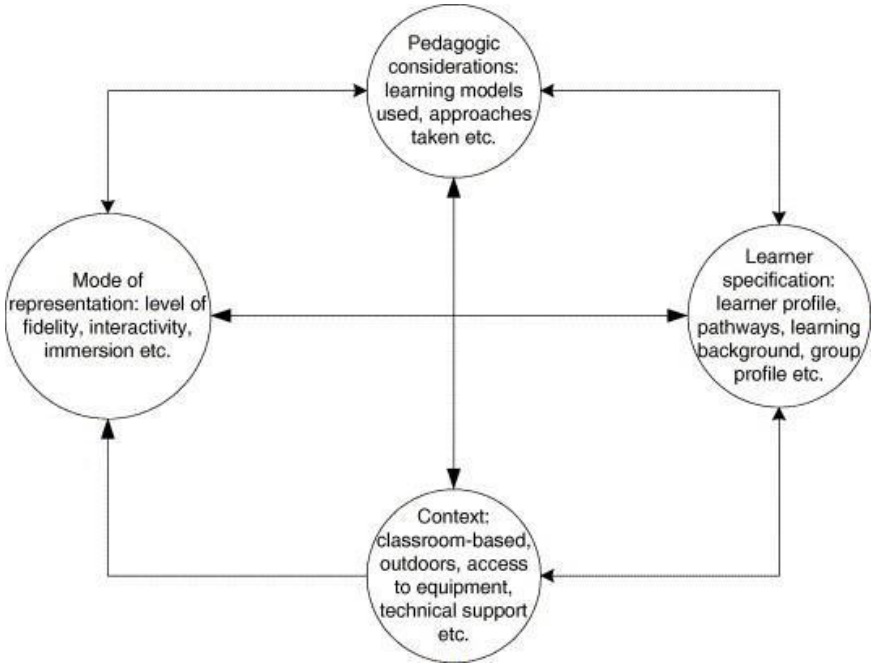

Figure.1: the Four Dimensional Framework

2. Contextualizing the use of SGs

The most fundamental distinction that can be made with regard to the context of SG use is between formal and informal settings. To date much of the attention dedicated to SGs has regarded their design for, and use in, informal settings. Here, learning results from "daily work-related, family or leisure activities" and "is in most cases unintentional from the learner's perspective" (Tissot 2004). In a recent wide-scale survey, the majority of students questioned expressed the view that they did not mind using games with overtly educational objectives in an informal setting (Dunwell et al. 2011). The issue of expectation is an important one to consider both in SG design and deployment; however, as this finding suggests, players are not necessarily put off by overtly educational objectives as long as game playability is good.

While the initial spotlight has been trained mostly on informal contexts, a growing body of experience is being accrued in the deployment of SGs within formal education settings as well. The pervasiveness of games is encouraging many teachers to look at their use in classes and, helped by the simultaneous bottom up push from students, games are more likely to become a part of the curriculum over the coming years. While games will certainly not replace the teacher, as some fear, they can open the way to more creative approaches that could have a significant impact on teaching practices.

To date experiences in SG deployment in educational settings have mostly regarded the use of COTS (commercial off-the-shelf games). Only to a lesser extent has it involved digital games purposely designed to pursue a more overtly educational agenda, related in some way to curriculum (or cross-curriculum) concerns. COTS games are increasingly being considered for education purposes, given their popularity, validity and cost-effectiveness with respect to developing SGs ad-hoc for supporting specific curricular activities. A number of successful deployments in formal education settings have been documented. One example is Blunt's adoption of COTS management simulation videogames (Industry Giant II, Zapitalism and Virtual U) for business studies (Blunt 2007). Other COTS games already being used in the classroom include Civilization (history), Age of Empires II (history), CSI (forensics and criminal justice), The Sims 2 (making complex social relationships), Rollercoaster Tycoon (engineering and business management), and SimCity 4 (civil engineering and government). For some of these there is a clear match between the game's explicit content and classroom subject; for others, a match is sought between the aims and skills involved in the course of study and the game's underlying strategies and gameplay. Other noteworthy initiatives that have used these and other COTS include Learning & Teaching Scotland's Consolarium, the Institute of Play's Quest to Learn Middle School in New York, North West Learning Grid's DiDa program in England (Derryberry 2007) and Futurelab's Teaching with Games project (Sandford et al. 2006).

While such experiences indicate that games have strong potential for improving learning, there is still a relative lack of solid and reliable research findings about integration of SGs into teaching and learning. This leaves questions unanswered and as a result the potential remains largely untapped in mainstream formal educational. In order to understand how games can best be exploited within a formally structured educational context, we need to look not just at the *nature* of the game as such but also at *how* the game and its characteristics can be adopted and leveraged to enhance learning within the structural, organisational and cultural constraints of institutional education (Johnston & Whitehead 2008).

This entails broad consideration of ICT-supported innovation in formal education, which is informed and driven by a multiplicity of interrelated factors like new tools and pedagogies, as well as the new organisational roles and relationships that are shaped by learner-centred and collaborative approaches to the learning process.

2.1 The new learning panorama and the use of SGs in formal educational settings

The educational panorama presently defined as "new" by most researchers (Ala-Mutka et al 2008) has been (and still is) deeply influenced by the availability of new ICT tools, and learners are now more adept at using these tools. As stated above, SGs can play a major role here in instilling innovation in learning processes: they present immersive educational worlds (de Freitas and Neumann 2009) where students can be more deeply and actively involved in educational activities.

As proposed by Ott (2011), figure 2 contrasts the traditional learning situation in formal educational contexts (left) with that (right) typified by the new learning community.

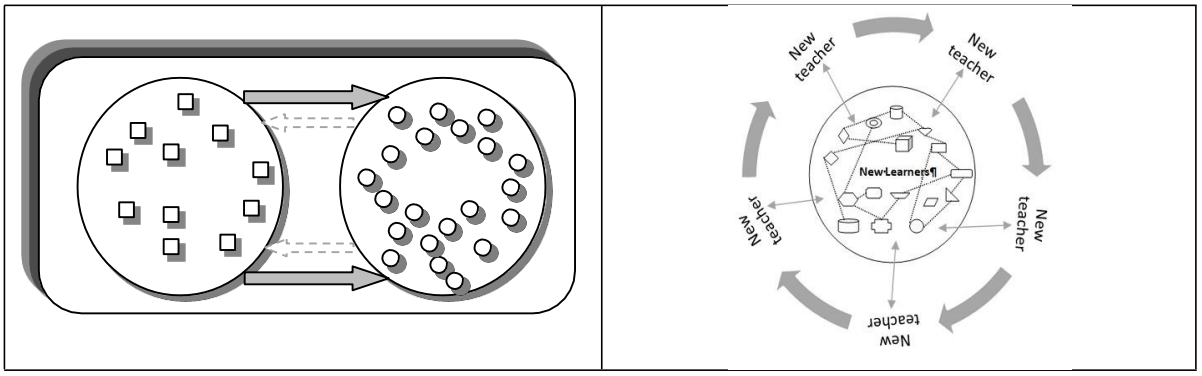

Figure.2: Traditional relationship between teachers-learners (left) vs. the new learning community (right)

In the former, teachers mainly act as the information providers and students the recipients, with a prevailingly unidirectional information flow between the two groups. In addition, the two groups are strictly separate and their respective members (teachers/learners) are depicted as being similar / identical to each other (teachers-squares; students-circles) since the (reductive) nature of the information transmission-reception paradigm attributes little real value to the actors' individual characteristics.

By contrast, the second picture represents a vision that is both learner centred and based on dynamic collaboration among all the actors involved. Here learners are represented in different shapes, instantiating the value of their individual differences. They assume the central position, are peer linked (work together, cooperate, network) and have reciprocal, frequent interactions with teachers, who also work in a team and not in isolation.

Against the background of this new learning panorama, we take a brief look at the challenges to wide-scale take-up of SGs in formal education, examining key aspects such as the educator's role, curriculum issues and pedagogical approaches.

3. The key role of educators and curriculum issues

Facilitating educational processes with technology is a multi-faceted process. SGs in particular have been looked at as educational tools that enhance knowledge transfer, offer good hands-on practice and enable both teachers and students to get a new perspective on learning. SG-based learning activities lend themselves to different pedagogical approaches and didactic concepts.

In order to exploit this potential fully, educators are called on to possess a range of competencies and assume a variety of roles; they need to be knowledgeable in the SG's content and mechanics, to be instructional designers, subject matter experts and pedagogically open to new ways of designing curriculum and tailoring classes assisted by technology.

Successful adoption of SGs is not only a question of identifying a suitable game for a given subject, but also of knowing what subjects and skills can benefit from a games-based approach, when and how an SG is best deployed, what stage of the learning path is most appropriate, and how to manage contextual factors. Ignoring these factors would not only jeopardize achievement of immediate learning goals, but could compromise the class as a whole. In shifting away from traditional educational approaches, teachers not only need to think outside the box but also to be multi-skilled, IT-knowledgeable, brave, curious and trans-disciplinary. Considering the educational effectiveness of SGs means taking into account a multiplicity of factors: the actors, the stage and the play.

It is important for teachers to be able to "easily augment the game with instructional activities that preserve the context (situated cognition) of the game, e.g. by extending the goals and character roles of the game into the classroom (Van Eck 2006). This means that teachers need to know the game well, propose specific learning paths, verify their effectiveness, and most importantly set the gaming experience in a sound overall educational framework. This work is crucial when we consider that "such games may not always meet the individual requirements of lecturers whose courses are tied to specific learning outcomes" (Rooney et al. 2009).

When using games, teachers are no longer solo voices in a concert; education with SGs shifts from "learning by listening" to learning by doing, in which students are actors and the teacher is the director on the stage (Garris et al 2002) who fosters participation and engagement, providing support, feedback and assessment. As well as playing a key role in support strategies, the teacher is also central in the critical phase of debriefing, where all the threads of the process are tied together. While some authors consider that games may substitute a teacher in cases involving specialized topics and

particular cost/time/space barriers, it is highly advisable that educational activities should make reference to an educator, if only for guidance (Egenfeldt-Nielsen 2006).
The best teacher will blend enthusiasm for using games with knowledge to be constructed so as to render a meaningful learning experience for each student. Indeed, "not only should teachers know the game well, propose specific trajectories to the students and verify effectiveness" (Bellotti et.al 2010), they also need to be mediators and foster post-game discussions: "the teacher can pop up some things from the game" and ask the students what they think about a situation or what made them act the way they did, as discussions lead to reflection (Whitton 2010). Learning goals are most successfully attained when the teacher has a clear sense of the task set, his mediation, and the type of game selected.
The curriculum is an embodiment of an educational system, be it K12, HE or company training. It is a complex and evolving set of rules, experiences and documents, a complex pedagogical project that contains design, practice and assessment stages, guidelines on practice and the competences to be formed, along with assessment types.
When designing a curriculum based on competences, one must carefully consider the 21st century curriculum, which is outcome based, centred on what students know and can do. It is a curriculum focused on the upper levels of Bloom's taxonomy - analysing, evaluating, creating (Krathwohl 2002); it is research driven and based on active learning. The student is no longer spoon-fed, but actively helps himself from the educational chunk, under more or less guidance according to age and moment of the lesson. It is a curriculum connected to students' interests, experience and talent, and relates to the real world. It allows for a certain degree of student freedom of choice in selecting what to learn, and when and how to do so, according to the learner's cognitive and metacognitive abilities. As games have already been labelled as valuable instructional methods and teaching strategies (Gredler 1996), considerable benefit would be gained from aligning games with the curriculum. However, introducing SGs into the curriculum requires careful consideration by decision-making bodies and teachers alike. Research has yet to present clear guidelines to help educators incorporate games in their practice in such a way as to ensure a smooth continuum from theory/planning to deployment and evaluation.

4. A walkthrough of new pedagogical approaches relevant to SGs

The use of situated cognition as a learning model enables educators to bridge theory and practice by placing students in environments that resemble the context in which their learning will actually be used (David & Watson 2011). SGs enable situated learning as a means of thinking differently about the transfer of learning and of facilitating learning in the same context in which it is applied through social processes of knowledge co-construction (Leemkuil et al. 2003; Souza e Silva & Delacruz 2006). In this respect SGs yield a series of benefits (Gee 2003; Aldrich 2009): students learn about the conditions under which the new knowledge can be applied; they are more prone to engage in problem-solving; they can experience the implications of the knowledge gained; and they can structure knowledge in ways that are appropriate for later use, since they are using the new-gained knowledge in context.
Deep reasoning and learning is stimulated by problems that create cognitive disequilibrium, such as obstacles to goals, contradictions, conflict, and anomalies (Newman & Newman 2007). SGs create circumstances where students can experience the discrepancy between something new and what they already know or believe. Gameplay can address specific pedagogical objectives for communication, education and training, and situate learners in virtual realities so that they can handle complex problems and tasks; learners face situations requiring them to apply their theoretical knowledge in practice.
Expertise is developed through experience, and experience is gained through practice. Because scaffolding is an effortful process full of challenges, it will take time to master. Scaffolding is not a stand-alone approach to instruction, but one element within the philosophy and techniques that guide teaching (Walqui & Van Lier 2010). Scaffolding of instruction activates the role of teachers as assistants of the learner's development and as providers of support structures that enable learners to get to the next level. Students need guidance to develop their individual thinking and SGs have the potential to lead to the generation of valid understanding of the subject taught.

4.1 SGs and collaborative learning: focus on collaboration

In the new learning panorama outlined above, teachers and learners collaborate to achieve learning goals. Interest in collaborative learning has grown in recent decades, supported by studies showing how peers really learn while performing group activities. Learners can build on each other's knowledge and provide mutual feedback (Dillenbourg et al. 2009). Advantageous peer interactions such as

providing and receiving explanations, co-constructing ideas, and negotiating meaning can be found in collaborative learning environments.
In the world of SGs, new technological functionalities have recently emerged that have led to the development of engaging collaborative game environments for learning. Accordingly, collaborative SGs should be taken into account as potential multi-sensorial learning tools that combine the benefits of collaborative and games based learning. Following Gee (2005), collaborative games not only allow individuals to participate in the same game, but open up a field for learners to construct understandings by interacting with information, tools and materials as well as collaborating with others.
There are still few examples of SGs that embed a collaborative pedagogical approach. One is Gersang, a pedagogical adaptation of a commercial Massively Multiplayer Online Role-Playing Game (MMORPG) (Kimet al. 2009). Deployment of this game in a middle school classroom permitted a qualitative and economic solution for enhancing students' social problem-solving abilities through think-aloud and modelling processes. In higher education, Baker and colleagues (2004) designed and tested Programs and Programmers, a dyad game intended to help software engineering students gain better understand of software development processes through active, collaborative and competitive gaming practices. Mawdesley (2010) aimed to study how the introduction of two different SGs could improve the learning experience in an applied construction project management program: the Mug Game and Canal Game case studies revealed significant improvement in the communication and presentation skills between peers that had used those games. Chang and colleagues (2009) developed and implemented SIMPLE, a SG environment for management students designed to raise teaching effectiveness and improve classroom practice. Some interesting results could be seen from collaborative playing experiences; students developed internalized knowledge and appeared more interested in the real world applications of the concepts practiced. These experiences showed how deployment of both COTS and SGs can help students practice and improve metacognitive processes and lead to more concrete problem-solving behaviours among peers.
To make collaborative learning effective in terms of learning outcomes and reduced organizational loads, guidance and a scaffolding process are required (Kreijns et al. 2003). This applies especially to SGs, where students' cognitive load should be devoted to the activities leading to attainment of learning objectives.
An interesting term that shows up when introducing SGs in management education is "coopetition", defined as collaboration within the group and competition between groups (Fu & Yu 2008). Competing while cooperating to win a game can be regarded as a successful learning strategy, as it stimulates different types of knowledge acquisition (Ke & Grabowski 2007). Competitive learning environments encourage students to develop higher analytical skills, while collaborative learning situations prompt students to demonstrate higher synthesis skills. Competition and collaborative pedagogies have proved to be effective techniques for enhancing learning performance in face-to-face learning environments.

5. Conclusive remarks

This paper reports some key challenges in the adoption of Serious Games within formal education. These are examined from different perspectives as part of a joint exploration into the topic conducted by a group of partners in the Games and Learning Alliance (GALA) who are investigating the pedagogical dimension of SGs. The ultimate aim is to provide useful indications and support to help SGs become more widely and effectively adopted in formal educational settings. The kinds of support that may be given in pursuit of this aim could include: better training for tutors, simpler tools for tutors to author learning game activities (Olimpo et al., 2010), dedicated web based communities and resources for practitioners, more institutional support structures for tutors, and wide-scale access to case studies and existing game content.
In the near future game-based environments are likely to become even more immersive, both in terms of technology and game design. Other developments on the horizon include tools for tutors to create tailored learning scenarios, intelligent tutoring environments that allow tutors and students to author and choreograph experiences (de Freitas & Neumann 2009), learner game creation (Vos, Meijden &

Denesen 2011) and integration of metacognitive tools, especially in support of collaboration. Given these future directions, the issues brought to light in this discussion are destined to take on even greater significance, as educators are likely to require a range of support options to help them gain solid understanding of how best to exploit the new opportunities on offer.

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