

Aspects of the integration of games into educational processes

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Abstract

This paper presents the results of a literature search and review focused on the integration of digital games into educational processes, specifically in primary schools. It briefly analyses around 78 papers reporting research carried out in a range of different countries and with a variety of educational objectives. The study confirms the increasing wealth of scientific studies dealing with game based learning and its implementation in formal educational contexts. This also holds true for primary education, which is at the core of this study. The review reveals that in this sector there is a predominance of papers that could be classified as theoretical or as position papers; only 78 out of more than 700 published papers surveyed actually reported concrete school experiences of any kind. Detailed analysis of this sub-group has highlighted some clues that may prove useful for interpreting the data as a whole and for reflecting on the current and future trends that they may indicate.

Keywords: Game-Based Learning; Serious Games; Primary Education; Literature Review; Educational Process

1. Introduction

Game Based Learning (GBL) is widely recognized as a potentially powerful approach for learning (de Freitas & Maharg, 2011; Zyda, 2005; Kirriemuir & McFarlane, 2004). Recent studies have highlighted the opportunities that digital games offer to support immersive, situated and learner-centred educational experiences (de Freitas, 2006), with considerable capacity to enhance students' engagement and motivation (Boyle et al., 2012) [5]. Researchers focusing on the effectiveness of game-based learning have stressed the contribution that games may offer for reaching a variety of learning goals (McFarlane et al., 2002), not only *within* subject areas like mathematics (e.g. Kebritchi et al., 2010) but also *across* them, supporting transversal skills like logical thinking (Bottino et al., 2009). Alongside the increasing number of field experiments being conducted by researchers, there is now also increased deployment of games in teaching practice. Thus, a growing body of experience is being accrued in the use of digital games within formal education settings. Nevertheless, as underlined by Razak et al. (2012), "*educators still find it a challenge to integrate this approach in their teaching practice*"; this indicates that there is still a need for further guidance and a general rethink of pedagogical approaches (Arnab et al., 2012; Sandford et al., 2006).

This paper presents the results of a literature search and review aimed at investigating the actual concrete use of digital games in primary schools. It follows a wide-ranging review and study carried out by Connolly and colleagues (2012) reporting "*empirical evidence about the impacts and outcomes of computer games and serious games with respect to learning and engagement*". This study, by contrast, focuses on trends in the process of integrating games into (primary) education and how these relate to the concerns and agenda of the research world.

2. A literature search and review of digital games in the primary classroom

In the effort to gain a clearer picture of the extent to which digital games are being adopted in primary schools and on how that process is unfolding, the authors performed an extended literature search. The ultimate objective was to shed more light on concrete field experiences being conducted in school settings.

2.1 Search and review methodology

The raw data for the survey were derived from two web services that aggregate bibliographic records from a range of major databases of scientific literature. One is Thomson's Web of Knowledge, which is generic, and the other is the University of Western Scotland's Serious Games Literature Database*, which is specifically dedicated to academic papers and publications related to GBL (Connolly et al., 2012).

Given the stated aims, the threshold criteria for inclusion of any paper in the review were that it should report:

- use of one or more digital games for learning;
- details of an experience of some kind or other, not just reflection on the educational potential of digital games;
- piloting or adoption in primary school (up to the age of 10-11).

No specific limitation was posed on the type/category of games to be considered (Djaouti et al., 2008).

The timespan considered was from 1992 onwards, while the search terms used were as follows: serious game, serious gaming, digital game, digital gaming, educational game, educational gaming, learning game, computer game, computer gaming, primary, elementary, K-12, young, preschool; where appropriate, keyword stems were used with a wildcard, e.g. <gam*>.

A total of 753 papers were returned from the global search and subsequent filtering using the above-mentioned threshold criteria generated 78 matches. As shown in table 1, these papers come from a variety of different bibliographical sources, with a preponderance from scientific journals in the fields of educational technology and psychology/educational psychology. Only a few come from game-specific conferences and proceedings, and a minority derive from journals in the field of ICT and health (those regarding field experiments in the use of games with disabled students as remediation aids).

* <http://icte.uws.ac.uk/search.aspx>

Table 1: Bibliographical sources of papers reporting field experiments at primary school level

The experiences reported in the papers were carried out in a variety of countries, the most prominent being the USA (31%), UK (15%), Italy (8%), Taiwan (7%) and Turkey (5%). A further 20% of papers came from a constellation of other countries, while the remainder were of unspecified origin. As well as reflecting the general predominance of American-origin papers in all scientific literature, the figure for the USA also reflects the strong interest that the application of game-based approaches holds in the US education system.

In order to perform a more detailed analysis of the experiences reported in the selected papers, reference was made to a grid developed at the Institute of Games for Learning - Microsoft Research specifically for the purposes of processing data from a literature review on game based learning (Ng et al., 2009).

As shown in Table 2 below, the grid encompasses ten main fields.

Table 2 - Summary/descriptions of the fields in the grid produced by the Institute of Games for Learning - Microsoft Research

For the purposes of our analysis, we considered only six of these ten fields. The omitted fields were numbers 4, 6, 7 and 8 (shown in Table 1 in italics): numbers 4 (*age of the participants*) and 6 (*research design*) were excluded because both of these were threshold criteria for defining the data set. The other two fields (7 and 8) were not considered because they are very specific to experimental concerns and as such were not central to our purposes.

3. Results

In this section we report the results from our literature search and review in an attempt to answer the following questions:

- What games were adopted in the experiences?
- What subject areas, if any, were covered?
- What were the most significant features of the experiences?

3.1 *The adopted games*

In the 78 papers covered in the review, the authors nominate a total of 54 different game titles that had been adopted for the reported experiences. Actually, around half of these experiences involved use of more than one game, and in some cases a suite of games was adopted. A further interesting finding was that several experiences used *game-making* environments and focused on game making as a learning activity. Quest Atlantis (now “Atlantis Remixed”[†]) was the game that figured most frequently in the experience reports (mentioned in 12 different papers). This prominence may be due in part to the fact that the game offers the possibility to engage students in different tasks, or “Quests”, dealing with different topics and areas.

To gain a clear view of the adopted games, two items from the Institute of Games for Learning grid were applied, namely “game type” and the “platforms” the games run on.

[†] <http://atlantisremixed.org/>

Game type

figure 1 - Literature review results: game type

Fig. 1 shows that the most common game type in the review are off-the-shelf educational games (36%), followed by educational games produced in-house (30%), which were mostly developed specifically for research purposes. This fairly even split between exactly two-thirds of the papers indicates strong academic interest not just in game design and experimentation, but also in integration processes per se. Non-educational off-the-shelf games occupy 13% of the total, while in 7% of cases the games were created by the students themselves.

Fifty-seven percent of the games used were developed for the personal computer, while 18% were browser-based and 9% ran on a console. These results no doubt reflect the ICT infrastructure typically used in primary schools. Given current trends, the figure here for browser games could be considered somewhat lower than expected. The reason for this may lie in the sometimes lengthy pathway that academic research follows, starting from initial game design and development (or selection), through experimental deployment, data gathering and processing, and finally writing and eventual publication of the academic paper. Indeed, even when GBL researchers focus on and pursue cutting-edge issues, their necessarily protracted “time to market” often puts them out of synch with rapid technological change. More agile and dynamic processes, possibly leveraging open academic publishing, could help to address this problem, which is certainly not exclusive to the GBL field.

3.2 Subject areas covered

Another aspect of interest is the extent to which game-related activities in primary schools are curriculum oriented, i.e. addressing subject areas and skills typically taught at this level. This could indicate whether game-playing is treated as part of “core” learning activities or rather as something discretionary and/or complementary.

To investigate this important aspect, the fairly general variables in the Microsoft grid (fig. 3) were supplemented with others at a finer grain of detail (fig. 4). Results in the former case show a prevalence of games in the maths-science domain (31%). This may well correlate with the 36% of off-the-shelf educational games shown in fig 1; over the past decade there has been a strong vein of edutainment-type games designed to help young learners learn/practise basic maths concepts and skills. This is especially true in the USA, the most prevalent country of origin of the papers (reported later in the paper). Twenty-six per cent of the games address general skills like perception, cognition, problem solving, and social skills rather than specific curriculum contents. A substantial percentage of games (19%) target language skills, while 15% focus on skills and knowledge in topics that mostly fall outside the scholastic realm (road safety, health, etc.). All of these results are perhaps to be expected in the primary school target, where there is usually a fairly limited degree of subject specialization beyond the acquisition of basic literacy and numeracy skills.

Curriculum based or not

figure 2 - Literature review results: curriculum based or not

In similar terms, figures for typical primary school subjects (fig. 4) show that mathematics and language (individually or combined) comprise 37% of subject coverage. It is interesting to note that transversal skills such as reasoning and perceptual abilities globally cover 20%, while health appears to be an emerging area (14%), as is game design and building (7%).

Subject areas

figure 3 - subject areas addressed by the games in the experiences

3.3 Some key features of the experiences

In an attempt to trace a clearer profile of the reported game-based experiences, we identified and extrapolated three extra features: 1) the number of students involved; 2) the methodology adopted for data gathering; 3) the main aims and expected outcomes of the experiences.

As Fig.5 shows, the research studies in the review draw on samples of varying size.

Sample size

figure 4 – Literature review results: sample size

The largest proportion (34%) is based on a medium-sized sample ranging from 30 to 100 participants. In 17% of cases relatively small-scale samples were involved, involving from 11 to 30 participants. Almost the same percentage of cases (16%) drew on a large sample (101 to 300 participants), while 15% were based on samples of less than 10 participants. Only 7% of the studies were carried out with very large samples numbering 300 participants or more. It comes as little surprise that samples tend towards the smaller rather than the larger end of the scale given the practical difficulties involved in running class-based experiments at primary school level.

A range of different techniques and means were used for data collection (fig. 6). The most common approach adopted was interview and focus groups (22%), followed by observation (16%), collection of qualitative data from questionnaires and spontaneous productions (14%), and academic tests or assessments (13%). Other techniques adopted include the recording of gameplay performance (9%), questionnaire-based collection of quantitative data on aspects like such as motivation (8%), computer-based data logs providing info on play duration etc. (6%) or audio recording and discourse analysis (5%).

Data type

figure 5 – Literature review results: data type

To some extent, these findings reflect the different aims of the reported experiences (fig. 9). Research data were mainly gathered for the purposes of: 1) analysing performance and evaluating learning potential and effectiveness (36%); 2) evaluating involvement and behavioural attitudes of learners involved in game-based activities; 3) studying game characteristics and features as part of the game development process.

Result type

figure 6– Literature review results: results type

The strongest research focus is on how the game promotes learning (30%), while in 22% of cases it's on how the game fosters aspects like motivation, satisfaction, etc. Ten per cent of the papers are devoted to other attitudes and behaviours (aggression, relational skills, etc.), while 44% focused on game design and interface features (including acceptability and usability). Once again, these results may well be influenced by the primary school target range.

4. Discussion and Conclusions

The literature review reported here provides a thought-provoking picture of the current employment of games in actual primary school settings. More than two-thirds of the experiences fall within the second half of the review's twenty-year time span (1992 to 2012), indicating a recent rapid increase in research interest. Another finding of note is the variety in the game environments used, which includes the design of interactive multimedia applications (Hotzoglou, 2012)] by adopting game-making tools (Earp et al., 2012) and other game genres among those games now commonly referred to as Serious Games, i.e. games "for purposes other than entertainment" (Sorensen & Meyer, 2007; Michel & Chen, 2006).

The wide variety not only in adopted tools but also in the methodology employed (e.g. collaboration and competition (Earp et al., 2012), curricular areas addressed and expected outcomes provides an interesting basis for reflecting on the plasticity and flexibility of games as learning/teaching tools, particularly for this audience.

It is perhaps not so surprising that the research papers in question should mainly report experimental/pilot studies investigating the impact of games on learners ("end-users") and learning processes. That said, it is interesting to note the significant number of experiences devoted to better understanding of game mechanics and interface features so as to facilitate and enhance learning.

The research-driven agenda underlying both the experiences and their reporting in scientific journals would explain why considerably less emphasis is placed on more "practical" considerations regarding contextual drivers and constraints, including educator praxis, even though these play an enormous part in determining take-up and effective deployment of game-based learning approaches. Indeed as Hanghøj and Brund (2010) argue, research in the educational games field has to a large extent followed a determinist, game-as-learning-machine perspective that has overshadowed consideration for the teacher's role. They postulate that "*game-based teaching can be*

understood as a complex series of pedagogical choices, practices and meaning-making processes, which can be analysed through the complementary notions of teacher roles, game modalities, and positionings”. Indeed, one area of particular research interest here regards the attitudes, approaches and tools (Minovic et al., 2010) that educators adopt (e.g. collaboration and exchanges with other teachers (Deed & Edwards, 2011) when they set about conceiving and designing game-based interventions, and how they represent and share those ideas with others (Ney et al., 2012).

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